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Foundations of Sensemaking Support Systems for Humanitarian Crisis Response

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Universiteit van Tilburg op gezag van de rector magnificus, prof. dr. Ph. Eijlander, in het openbaar te verdedigen ten overstaan van een door het college voor promoties aangewezen commissie in de aula van de Universiteit op vrijdag 25 maart 2011 om 10.15 uur door

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To those I wish were here

Preface

My involvement in the humanitarian crisis response domain started in March 2005, when I was part of a group of students who worked on projects regarding business continuity and disaster recovery in Colombo, Sri Lanka, in the aftermath of the Indian Ocean Tsunami. Even a few months after the disaster struck, its devastating impact was noticeable all around the area. Coincidentally one late evening during our stay, being at our hotel by the coast, we witnessed another tsunami “alarm”. We were not warned by an early warning system or by local people, but found out by accidentally reading a news report when browsing the internet. As has been extensively reported (Addams-Moring, 2007), we made sense of our environment and the threat in different ways, and decided to evacuate our hotel and move land inwards. At first, however, most local people decided not to evacuate their homes, even though they saw us fleeing to safer grounds. Luckily the earthquake did not cause a tsunami, because in hindsight we realized that the tsunami would have hit the local population together with us before we even got to know about the threat. This experience illustrates the potential and necessity of information systems to improve humanitarian crisis response, and was an important motivation for me to conduct this research.

The past four years I had the opportunity to conduct research in this highly interesting and relevant domain. I would never have been able to write this dissertation without the guidance, advice, and support of many colleagues, friends, and relatives along the way.

First of all I would like to thank Bartel for giving me the opportunity to do this PhD and supervise me. Bartel has always created opportunities for me to go to many different conferences and summer schools, to take part in courses, research projects, and exercises, and to conduct case studies all over the world. Bartel’s mixture of a serious and professional approach when needed with an informal and sociable approach when allowed for has made my time as his student highly instructive and enjoyable.

The second person who has been of invaluable help is Gerd. Gerd has been always there to advise and support me, both personally and professionally. During our joint studies in Colombo, Brussels, Kinshasa, and Finland I learned from Gerd how to conduct critical and original research, and was inspired by his approach and perseverance – in particular to explore highly ambiguous concepts such as Sensemaking. We had a lot of fun and unforgettable experiences during our trips together.

I would like to thank my committee members, colleagues from the ISCRAM association, and all those who contributed to shaping my research along the way with useful comments and feedback. I would like to thank Damir for his contributions in Sarajevo and the co-

development of the pilot experiment, Cas for his help with z-Tree, Meeri-Maria for the excellent preparation of and active participation in various case studies, and Ilkka, Risto, and Juha-Matti for their assistance in a case study.

There are several people who provided me with the opportunities for conducting this research. I would like to thank Paul Burghardt, Kees Nieuwenhuis, and Martijn Neef for managing the ICIS project¹. I would like to thank Center and the department of Information Management at Tilburg University for providing me with the facilities for carrying out this research. I would like to thank Kristiina Rintakoski from CMI for organizing the “Information sharing models and interoperability” project and giving me the opportunity to take part. Furthermore, I am grateful to Geert Gijs, Ronald Ackermans, and Marc Devalckeneer from B-FAST for giving me field training and including me in their Triplex exercise mission, Johan Heffinck, Nigel Snode, and Gisli Olafsson for giving me the opportunity to participate in the OSOCC and the needs assessment process during Triplex, and Erik Kastlander for giving me various opportunities. The insights and experiences shared by all interviewees and the humanitarian crisis response practitioners Geert, Ronald, Marc, Johan, Nigel, Gisli, and Erik were invaluable and instructive for me.

There are many friends whom I would like to thank for the great times these four years in Tilburg; in particular I would like to mention Ben and Michele. Other special thanks go out to Erwin, Rob, and Wannes, who have been my friends from primary school onwards, and ever since I could always rely on and have good times with. I would like to thank Akos, Alerk, Amal, Amar, Amina, Andrea B., Andrea K., Anita, Ard, Bart, Benedikt, Benjamin, Chris, Corrado, Cristian, DJ, Edwin, Emiliya, Faiza, Flaminia, Francesco, Gabriele, Gema, Heejung, Jagath, Jeewanie, Jelmer, Jon, Joost, JW, Karen, Katie, Khoa, Kristel, Linde, Marcel, Marco, Maria, Marina, Michael, Momo, Norma, Oktay, Owen, Paola, Patricio, Pedro, Piero, Rafiq, Renata, René, Rick, Stefania, Tom, Victor, Wimme, Yan, Yehia, and all others whom I have not mentioned explicitly for the tiring but fun time in the “Gomorra” futsal team, the mind-boggling but entertaining time at the pub quiz, the successful evenings and chess/futsal events as “Black Sheep”, the exciting and great “fantacalcio” rounds, the many social events with the “LG”, nice lunches and dinners, the board-game-playing and football-watching afternoons and evenings, and all the other great experiences. I am very lucky and happy to have met and hung out with you all.

There have been some people very close to me who have always been there for me. I would like to thank my family, and in particular my parents Dagma and Harrie, my sisters Bianca, Melissa, and Yvette, and our dog King for their wonderful and continuous support. Last but not least, I would like to thank Cristina. She has been my best friend during the PhD, and has been of tremendous importance to me – both to complete this research and personally.

's-Hertogenbosch, February 2011

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List of Acronyms

ANOVA	Analysis of Variance
ANPC	National Authority for Civil Protection (Portugal)
ASF	Association pour la Santé Familiale
BEAC	Barents Euro-Arctic Council
B-FAST	Belgian First Aid and Support Team
BiH	Bosnia and Herzegovina
CECIS	Common Emergency Communication and Information System
CMI	Crisis Management Initiative
CRS	Catholic Relief Services
DERMIS	Dynamic Emergency Response Management Information System
DFID	United Kingdom Department for International Development
DG	Directorate General
DRC	Democratic Republic of Congo
DSS	Decision Support Systems
EC	European Commission
ECHO	European Commission Humanitarian Aid Office
ESDP	European Security and Defense Policy
EU	European Union
EUFOR	European Union Force
EUPM	European Union Police Mission

EUSR	European Union Special Representative
GIS	Geographic Information Systems
GSS	Group Support Systems
ICC	Intraclass Correlation Coefficient
ICIS	Interactive Collaborative Information Systems
ICRC	International Committee of the Red Cross
IPTF	International Police Task Force
IRF	Item Response Function
IRT	Item Response Theory
IS	Information Systems
ISCRAM	Information Systems for Crisis Response and Management
ISRF	Item Step Response Function
LEMA	Local Emergency Management Authority
LOT	Liaison Observation Team
MHM	Model of Monotone Homogeneity
MIC	Monitoring and Information Center
MONUC	Mission des Nations Unies en République Démocratique du Congo (UN peacekeeping mission in the DRC)
MRT	Media Richness Theory
MSF	Médecins Sans Frontières
MST	Media Synchronicity Theory
NATO	North Atlantic Treaty Organization
NGO	Non Governmental Organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OSC	On Site Command Center
OSOCC	On Site Operations Coordination Center

PDA	Personal Digital Assistant
PS	problem statement
RQ	research question
SIDA	Swedish International Development Cooperation Agency
SIR COPE	Social context, Identity construction, Retrospection, Cue extraction, Ongoing, Plausibility, Enactment (the 7 Sensemaking properties)
SMS	Short Message Service
SSS	Sensemaking Support Systems
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
WFP	World Food Programme
WHO	World Health Organization
z-Tree	Zurich Toolbox for Readymade Economic Experiments

Chapter 1

Introduction

The information-processing systems of our contemporary world swim in an exceedingly rich soup of information, of symbols. In a world of this kind, the scarce resource is not information; it is the processing capacity to attend to information. Attention is the chief bottleneck in organizational activity . . .

Herbert Simon in *The Sciences of the Artificial* (1996)

1.1 Crucial Stages and Turning Points

The term “crisis” derives from the ancient Greek word *κρσις* (krisis), meaning moment of decision, judgment, or choice. In Greek tragedies for example, *κρσεις* (kriseis) were turning points where human choice could make a fundamental difference to the future (Shrivastava, 1993). Nowadays we use the term crisis for either “a crucial stage or turning point in the course of anything”, which reflects the original meaning of the word, or “a time of extreme trouble or danger” (Gilmour, 2003). In this dissertation we use the term crisis to describe the latter type of events, when people are struck by disastrous circumstances. As a consequence of such events, however, people will inherently find themselves at a crucial stage or turning point in which they do not only need to make decisions on the course of action they will pursue, but also need to make judgments on what is happening around them and on what the decision context is.

We mainly focus on “crucial stages” and “turning points” faced by humanitarian actors who work in crisis situations caused by natural hazards or conflicts. These actors typically operate in a complex and uncertain environment, under difficult circumstances of high stress levels, time constraints, and high stakes, and with crises occurring anytime and almost continuously. Unlike in mainstream environments, the expectation for these actors is that bad things *will* happen. Moreover, various types of information problems complicate the response, such as inaccurate, late, superficial, irrelevant, unreliable, and conflicting information (Van de Walle and Turoff, 2007; Van de Walle et al., 2009). In sum, actors

face considerable information processing challenges for decision making on the course of action to pursue, making judgments on what is happening, and understanding what is going on in order to decide and act appropriately.

Information and communication play an important role in crisis response and management (Hale et al., 2005). It has been documented on numerous occasions that communication problems can be the cause of a crisis, as was the case in, for example, the Mann Gulch fire (Weick, 1993), the Challenger accident (Winsor, 1988), and the Tenerife air-traffic disaster (Weick, 1990), or further intensify it. Ex-post analyses of such accidents demonstrate that the underlying cause of these information and communication problems was that people failed in making sense of the situation at hand.

1.2 Sensemaking

The main theoretical concept underlying this dissertation is Sensemaking¹, a meta cognitive framework that can be used to obtain a grip on the equivocal external environment and its proneness to multiple interpretations. Sensemaking is usually triggered by a sudden loss of meaning, described by Weick as a “cosmology episode,” in which “both the sense of what is occurring and the means to rebuild that sense collapse together” (Weick, 1993). When people experience a cosmology episode, they are being thrown into an ongoing, unknowable, unpredictable streaming of experience (Weick et al., 2005) and try to make sense of things and make things sensible (Weick, 1995, p.16) by addressing the questions, “what is happening out there?”, “why is it taking place?”, and “what does it mean?” (Choo, 2006; Dervin, 1983; Weick, 1995). Sensemaking is thus about how people give meaning to what is happening in order to reduce the equivocality and ambiguity that surrounds them (Weick and Meader, 1993). These meanings “are constituted and reconstituted through the dynamic, reciprocal, and iterative processing of environmental information” (Sutcliffe, 2001).

Sensemaking has been studied in various disciplines, such as in organizational studies (Weick, 1995), library and information science (Dervin, 1999), command and control (Grant, 2005), software engineering (Selvin et al., 2010), and intelligence analysis (Pirolli and Card, 1999). In this dissertation we approach Sensemaking from Weick’s organizational studies perspective.

Organizational and management scholars have defined and used the concept of Sensemaking in different ways. March and Olsen related Sensemaking to experiential learning (Choo, 2006, p.77), as “individuals and organizations make sense of their experience and modify behavior in terms of their interpretations” (March and Olsen, 1976, p.56). Huber and Daft (1987) talked about Sensemaking as the construction of sensible and sensible events. From Starbuck and Milliken’s perspective, “Sensemaking has many distinct aspects: comprehending, understanding, explaining, attributing, extrapolating, and pre-

¹In line with Van Den Eede (2009), we distinguish the concept of Sensemaking discussed in this dissertation from the colloquial “sense making”, and therefore use this spelling. To avoid any confusion we capitalize Sensemaking throughout the dissertation.

dicting, at least. (...) What is common to these processes is that they involve placing stimuli into frameworks (or schemata) that make sense of the stimuli” (Starbuck and Milliken, 1988). This broader notion of Sensemaking is also acknowledged by Thomas et al. (1993), who view information seeking, processing, creating, and using to be central activities of Sensemaking. This means that Sensemaking is not a noun, but a verb; that it is a process, with sense as its product (Muhren et al., 2008b).

Sensemaking encompasses intuitions, opinions, hunches, effective responses, evaluations, and questions (Savolainen, 1993). Sensemaking deals with omnipresent discontinuity in continuously changing situations. “To understand Sensemaking is also to understand how people cope with interruptions” (Weick, 1995, p.5). Dervin labeled this “gappiness,” meaning that people are continuously confronted with dissonance, ill-structured problems, ambiguity, and equivocality (Dervin, 1999). Situations in which gappiness is most evident, such as crisis situations in which discontinuity is the rule and continuity the exception, are therefore settings in which Sensemaking is particularly relevant (Van Den Eede et al., 2004). We use Sensemaking similar to Weick (1993) to describe and understand how actors process information in crisis environments.

In the following subsections we discuss the properties that characterize Sensemaking (Subsection 1.2.1) and Sensemaking’s different levels of analysis (Subsection 1.2.2).

1.2.1 Sensemaking properties

We heavily rely on Weick’s extensive work on Sensemaking (Weick, 1985, 1988, 1993; Weick and Meader, 1993; Weick, 1995, 2001, 2005; Weick et al., 2005). He matured the concept of Sensemaking in organizations, among others by defining its underlying properties in his groundbreaking work on information processing in organizations (Weick, 1995). Although they might not be fully exhaustive nor exclusive in the scientific sense, they still are a grand attempt to render the way people deal with interruptions more tangibly (Muhren et al., 2008b). Weick (1995) defines seven different properties of Sensemaking. They can be captured by the acronym SIR COPE: Social context, Identity construction, Retrospection, Cue extraction, Ongoing, Plausibility, and Enactment (Muhren and Van de Walle, 2009; Muhren et al., 2008a,b, 2009; Nathan, 2004; Weick, 1995, 2001, 2005). Below we briefly discuss them.

Social context

“People learn about events when they compare what they see with what someone else sees and then negotiate some mutually acceptable version of what really happened” (Weick, 1985). Cognitive and social aspects of Sensemaking are inextricably linked. People need social anchors and a form of social reality (Weick, 2001), because what we say or think or do is contingent on what others say and think and do. Sensemaking requires talking, interaction, conversation, argument, and dialog with others (Muhren et al., 2008a).

Identity construction

Depending on who the Sensemaker is, the definition of what is happening will also change. What the situation means is defined by who one becomes while dealing with it or what and who one represents. “The Sensemaker is himself or herself an ongoing puzzle undergoing continual redefinition, coincident with presenting some self to others and trying to decide which self is appropriate” (Weick, 1995, p.20). An organization seeks to discover what it “thinks” and “knows” about itself and its environment. This construction of identity is the basis for imparting meaning to information within the organization and, eventually, determining what problems must be solved.

Retrospection

“Sensemaking is influenced by what people notice in elapsed events, how far back they look, and how well they remember what they were doing” (Weick, 2001). Weick et al. (2005) point out that answers to the question “what’s the story?” emerge from retrospect, connections with past experience, and dialog among people who act on behalf of larger social units. Answers to the question “now what?” emerge from presumptions about the future, articulation concurrent with action, and projects that become increasingly clear as they unfold.

Cue extraction

Sensemakers decide what to pay attention to (Nathan, 2004). Sensemaking is influenced by both individual preferences for certain cues as well as environmental conditions that make certain cues figural and salient (Weick, 2001). Sensemakers notice some things and not others. When making sense, people pay attention and extract a particular cue and then link it with some other idea that clarifies the meaning of the cue, which then alters the more general idea to which the cue was linked on an earlier moment, and so on. Extracted cues enable Sensemakers to act, which increases confidence and confirms faith in earlier cues (Muhren et al., 2008a).

Ongoing

Sensemaking has neither a beginning nor a formal end. Instead, it “takes place in a continuing and dynamic fashion as events unfold and Sensemakers continuously seek to understand what events mean in relationship to organizations” (Nathan, 2004). Most of us at any given time find ourselves “in the middle of something.” As we move from one situation to another, we make and revise assumptions and beliefs along the way. For Sensemaking it is important to maintain an ongoing understanding of events. Once you cannot keep pace with the action, you lose context, information, situated cognition, and tools made meaningful by actual use (Weick, 2005).

Plausibility

“Sensemaking is about coherence, how events hang together, certainty that is sufficient for present purposes, and credibility” (Weick, 2001). Looking for what is plausible is often of more practical help than finding accuracy (Nathan, 2004). Totally accurate perception is not needed, which is good because what is needed is that which is plausible and reasonable. Plausibility helps us explore what we see and energizes us to act; the search for accuracy can de-energize us as the search drags on and on.

Enactment

People often do not know what the “appropriate action” is until they take some action, guided by preconceptions, and see what happens (Weick, 1988). “Action is a means to gain some sense of what one is up against, as when one asks questions, tries a negotiating gambit, builds a prototype to evoke reactions, makes a declaration to see what response it pulls, or probes something to see how it reacts” (Weick, 2001). Action determines the situation, as it creates an orderly, material, social construction that is subject to multiple interpretations (Weick, 1988). The basic premise is that there is no objective environment out there separate from one’s interpretation of it. Thus, the organization creates or enacts parts of its environment through selective attention and interpretation.

Weick et al. (2005) formulate a gripping conclusion on what the seven Sensemaking properties are all about: “Taken together these properties suggest that increased skill at Sensemaking should occur when people are socialized to make do, be resilient, treat constraints as self-imposed, strive for plausibility, keep showing up, use retrospect to get a sense of direction, and articulate descriptions that energize. These are micro-level actions. They are small actions. But they are small actions with large consequences.”

1.2.2 Sensemaking levels of analysis

Weick (1995) and Wiley (1988) discuss three levels of analysis in Sensemaking: (1) the individual level, (2) the intersubjective level, and (3) the generic subjective level. The individual level of analysis is the most basic level, but as the social context always plays an important role in Sensemaking, one easily transfers to the intersubjective level of analysis. During times of stability, “some level of shared understanding needs to exist for coordinated activity to occur,” and there is an “enacted reality at group level in the form of routines, rituals, systems, norms, assumptions and beliefs,” (i.e., the level of generic subjectivity) (Balogun and Johnson, 2005). However, when individuals face change, generic subjectivity breaks down into intersubjectivity and takes the form of face-to-face conversations, interactions, exchanges, and continuous communication (Weick, 1995; Wiley, 1988; Balogun and Johnson, 2005). “Only by virtue of continuous communication are the exchanges and interpretations of intersubjectivity, and the shared understandings of generic subjectivity, developed and maintained” (Weick, 1995, p.75).

Most previous research does not explicitly mention the level of analysis, but is mostly focused on the individual and intersubjective level. Lately, the notions of “group Sensemaking” (Nosek and McNeese, 1997; Lee and Abrams, 2008) and “collaborative Sensemaking” (Qu et al., 2009; Paul and Reddy, 2010) have made their appearance, which refer to the Sensemaking level of generic subjectivity.

Many studies in “collaborative Sensemaking” base their work on Russell et al. (1993), who view Sensemaking as “the process of encoding retrieved information to answer task-specific questions”. In this view, Sensemaking is perceived as a process of analyzing a large amount of data and filtering out the information needed for a task. This is however similar to the notion of interpretation which Weick contrasts against Sensemaking: “When people discuss interpretation, it is usually assumed that an interpretation is necessary and that the object to be interpreted is evident. No such presumptions are implied by Sensemaking. Instead, Sensemaking begins with the basic question, is it still possible to take things for granted?” (Weick, 1995, p.14).

Nosek and McNeese (1997) were one of the first to discuss group Sensemaking and define it as “the elicitation and creation of group knowledge relevant to an emerging situation.” We view group Sensemaking as a process that is broader than merely socially constructing meanings and generating a shared understanding among group members. As Weick (1995, p.42) explains, “Sensemaking is also social when people coordinate their actions on grounds other than shared meanings as when joint actions are coordinated by equivalent meanings, distributed meanings, overlapping views of ambiguous events, or nondisclosive intimacy”.

In sum, there is scarce research on the group Sensemaking level when viewing Sensemaking from Weick’s perspective. In this dissertation we will examine both the combined individual/intersubjective level of Sensemaking and the – largely unexplored – group Sensemaking level.

1.3 Supporting Interpretive Information Processing: Towards Sensemaking Support Systems

A *work system* is a system in which human participants or machines use information, technologies, and other resources to perform processes for producing products or services for internal or external customers (Alter, 1999). Information Systems (IS) constitute a special case of work systems in which the processes performed and products and services produced are devoted to information, including activities such as information processing, communication, Sensemaking, decision making, thinking, and physical action (Alter, 2002). IS can affect the extent to which one gets a better picture of the environment (Sutcliffe, 2001; Muhren et al., 2008a; Weick, 1985), which is particularly needed in the hectic circumstances of crisis situations where actors face numerous information and communication challenges (Bartell et al., 2006; Maiers et al., 2005).

The intersection between IS and crisis management has been studied by, for example, Housel et al. (1986), Calloway and Keen (1996), and Turoff et al. (2004). Research

and practice have nevertheless shown that current crisis management IS are long overdue in practice (Van de Walle and Turoff, 2007).

Actors in crisis response could benefit from IS support in making sense of what is going on. Although noted some time ago, Weick's observation that IS are not really designed to support how people make sense of their environment is still valid: "[IS] contain only what can be collected and processed through machines. That excludes sensory information, feelings, intuitions, and context — all of which are necessary for an accurate perception of what is happening. (...) To withhold these incompatible data is to handicap the observer. And therein lies the problem" (Weick, 1985).

In the following subsections we discuss more in detail why there is a need for more Sensemaking support by IS (Subsection 1.3.1) and what our starting point is to examine the design of such systems (Subsection 1.3.2).

1.3.1 Information systems and Sensemaking support

Similar to Weick, we view Sensemaking as a process broader than the analysis of information or the creation of an end-product such as situational awareness. Sensemaking to us is an interpretive information process, for which the information itself is important, but also the information sources, people, organizations, information carriers, communication media, information systems, and intangibles such as the context, tacit knowledge, organization culture, experience, and intuition, and it is a process without an end.

Modern management and IS design have been heavily influenced by Herbert Simon et al.'s rational decision making schemes (March et al., 1958), suggesting a scientific deductive decision making with an almost complete knowledge of all relevant variables and from which an optimization can be made. For this reason, most IS are aimed at either storing and retrieving information in order to reduce uncertainty, such as database management systems and document repositories, or at analyzing and processing large amounts of information in order to reduce complexity, such as decision support systems (Van de Walle and Turoff, 2008). However, this might not always be helpful when coping with a variety of potential meanings, as is commonly experienced when trying to make sense of what is going on. Traditional, more computational information processing perspectives "tend to neglect the more interpretive aspects of information processing or the idea part that organizational information processing necessitates the creation of meaning around information in a social context" (Sutcliffe and Weick, 2008). Most IS currently even seem to replace or suppress the possibility to make sense of situations. For example, heavily inspired by Herbert Simon et al.'s work, IS research and practice use structured data as a substitute for information (Boland, 1987). However, information is not a commodity; it is a skilled human accomplishment. Information is meaning resulting from a person's engagement with data (Davenport and Prusak, 1998). IS should thus be designed to take dialog, interpretation and an individual's search for meaning as sacred (Boland, 1987). Even though the role of more intuitive information processes was inherent to the work of Simon from the start (Frantz, 2003), the way management was conducted and IS designed has been

based on rationalistic models ever since.

Lindblom (1959) was one of the first to challenge this view on decision making – and hence also the consequences for information processing – by a “science of muddling through”. Ratio became complemented by intuition in the sense that Lindblom acknowledged the importance of among others previous experiences and progress through “incrementalism” (Lindblom, 1979). Weick’s work on Sensemaking shares many similarities with Lindblom’s concept of “muddling through” (Turoff et al., 2009) and is particularly useful because it offers an analytical tool – i.e., the Sensemaking properties – that makes it possible to name and understand information processing activities which go beyond the rationalistic decision making schemes. Inspired by Weick’s work on Sensemaking, we take an interpretive information processing perspective on crisis management and humanitarian response in this dissertation.

Interesting and substantial research exists on Sensemaking and crisis situations (such as Weick, 1993), but relatively few studies use Sensemaking as an analytical lens for the design of information technology (Weick and Meader, 1993), and there is scarce research on how IS can support information processing challenges – specifically related to Sensemaking – in crisis management (see Landgren, 2005, for a notable exception).

We use the term *Sensemaking Support Systems (SSS)* (Weick and Meader, 1993; Weick, 1995; Muhren et al., 2008a) to denote systems that should be designed to support Sensemaking. As Weick (1995, p.179) put it, “we need to understand more about Sensemaking Support Systems as well as Decision Support Systems, which means we need to know more about what is being supported”. The processes that need to be supported, the interpretive and less explicit information processing mechanisms, are commonly designated as “intuition,” “experience,” or “gut feeling” and are considered a “black box” (Savolainen, 2006). Our research focuses on this black box and aims to identify the implicated information processes, in order to design better supporting systems. For this purpose we use the seven previously mentioned Sensemaking properties as building blocks in our research.

1.3.2 Design of Sensemaking Support Systems

Similar to Calloway and Keen (1996), we define IS support for crisis response as a multidisciplinary concept including not only information technology, but also social networks of response actors and organizational designs. An organization’s design can increase or reduce the information processing requirements and affect capacity (Sutcliffe and Weick, 2008). We take an interpretive information processing approach to organization design by stressing the importance of facilitating the Sensemaking properties in organization design and in particular IS support for the organization design.

The seven Sensemaking properties mentioned previously “have an effect on the willingness of people to disengage from, discard, or ‘walk away’ from their initial story and adopt a newer story that is more sensitive to the particulars of the present context” (Weick, 2001). Weick (2005) argues that an organization is more effective in accomplishing this when the context is created in which the Sensemaking properties are supported rather than inhibited. In Table 1.1 we summarize for each Sensemaking property (first column)

how Weick (2005) argues that it is supported (second column) or inhibited (third column) by the organizational form. Hence, in order to direct IS design to support Sensemaking, IS should aim to support the organizational supporting forms listed in Table 1.1 and avoid the organizational inhibiting forms. If well supported, the Sensemaking properties become important resources for Sensemaking.

Paraphrasing how Weick (2001, 2005) defined the organization form should support Sensemaking, we argue that SSS should:

- encourage conversation (support social resources);
- give people a distinct, stable sense of who they are and what they represent (support defined identity);
- preserve elapsed data and legitimate the use of those data (support backward noticing);
- enhance the visibility of cues (support equivocal cues);
- enable people to be resilient in the face of interruptions (support continuous flow of events);
- encourage people to accumulate and exchange plausible accounts (support possibility as criterion for narratives);
- encourage action (support enactive as form of action).

Table 1.1: Sensemaking properties and their organizational supporting and inhibiting forms (Weick, 2005)

Sensemaking property	Supported by	Inhibited by
Social context	Social resources	Solitary resources
Identity construction	Defined identity	Vague identity
Retrospection	Backward noticing	Forward noticing
Cue extraction	Equivocal cues	Confirmed cues
Ongoing	Continuous flow of events	Episodic flow of events
Plausibility	Possibility as criterion	Probability as criterion
Enactment	Enactive as form of action	Reactive as form of action

1.4 Problem Statement and Research Questions

Section 1.3 has emphasized the need for better Sensemaking support systems in humanitarian crisis response. Consequently, our problem statement reads as follows.

Problem statement. *To what extent can we lay the foundations of Sensemaking Support Systems for humanitarian crisis response?*

As a guideline to answer the problem statement, we formulate eight research questions. These research questions can be divided into three themes.

First, we need to gain more understanding of Sensemaking in the broader field of crisis management. We need to investigate how actors process information in crisis management, and understand the role of Sensemaking. To gain more understanding of Sensemaking, there is need for an examination of the different Sensemaking properties. Moreover, we need to investigate how information processing in general and Sensemaking in particular can be supported by IS in crisis management. The first, second, and third research question therefore read as follows.

Research question 1. *How do actors process information in crisis situations?*

Research question 2. *Can we validate the seven Sensemaking properties in crisis actors' information processing behavior?*

Research question 3. *What can we learn from crisis actors' information processing behavior for the design of Sensemaking Support Systems for crisis management?*

Second, we need to gain more understanding of Sensemaking in humanitarian crisis response and how it can be supported by IS. Because we expect that communication is important for Sensemaking, and communication is a more concrete process to observe, identify, grasp, and support than the Sensemaking for which it intended, the fourth and fifth research question read as follows.

Research question 4. *How does communication play a role in the Sensemaking processes of humanitarian actors in a crisis environment?*

Research question 5. *How can information systems support Sensemaking in humanitarian crisis response from a communications perspective?*

Third, we need to examine the relationship between Sensemaking and information sharing, as the latter is another important information process in humanitarian crisis response. Furthermore, we need to investigate whether the important role that Sensemaking has according to theory can be validated in practice, and gain more understanding of the influence of Sensemaking support by IS on performance. For this reason we first need to quantify the attainment of Sensemaking. As humanitarian crisis response is mostly conducted by teams, we continue by examining Sensemaking on the group level. Therefore, the sixth, seventh, and eighth research question read as follows.

Research question 6. *Can we measure group Sensemaking attainment in humanitarian crisis response?*

Research question 7. *How are Sensemaking and information sharing related to each other in humanitarian crisis response teams?*

Research question 8. *Does Sensemaking attainment influence performance in humanitarian crisis response teams?*

The answers to these eight research questions will allow us to formulate an answer to the problem statement.

1.5 Dissertation Outline

This dissertation is a collection of four essays, Chapters 2–5, which collectively attempt to lay the foundations of SSS for humanitarian crisis response. Figure 1.1 provides an overview of how we built up our research to attain this goal and answer the problem statement. The top part of the figure illustrates the triangulation of research methods that characterizes our research. We first used qualitative methods (interpretive case study research, observation, and participant observation) which enabled us to gain a better understanding of the concepts under study. Second, we employed quantitative methods (survey research and experimental research) to test specific hypotheses on the concepts we gained understanding of. As can be seen in the second row of blocks in Figure 1.1, through these different types of research we have (1) obtained a better understanding of Sensemaking in humanitarian crisis response, (2) studied and validated the physiology of Sensemaking, (3) applied the Sensemaking properties to communication, (4) managed to measure Sensemaking, (5) related Sensemaking to group decision making and information sharing, and (6) demonstrated its importance. Throughout the essays we relate Sensemaking to information processing challenges, decision making, communication activities, and information exchange. As illustrated in the third row of blocks in Figure 1.1, we integrate Sensemaking into different well-established IS streams of research: emergency response management IS, media synchronicity, and group support systems. Table 1.2 provides an overview of where the different research questions (RQs) and the problem statement (PS) are addressed in this dissertation.

Table 1.2: Problem statement and research questions addressed by the different chapters

	RQ1	RQ2	RQ3	RQ4	RQ5	RQ6	RQ7	RQ8	PS
Chapter 2	x	x	x						
Chapter 3				x	x				
Chapter 4						x			
Chapter 5			x				x	x	
Chapter 6	x	x	x	x	x	x	x	x	x

In Chapter 2 we describe our first progress to understanding Sensemaking. We explore four information processing challenges commonly experienced in crisis situations, which form the basis of the design of IS that should support actors in these situations. We

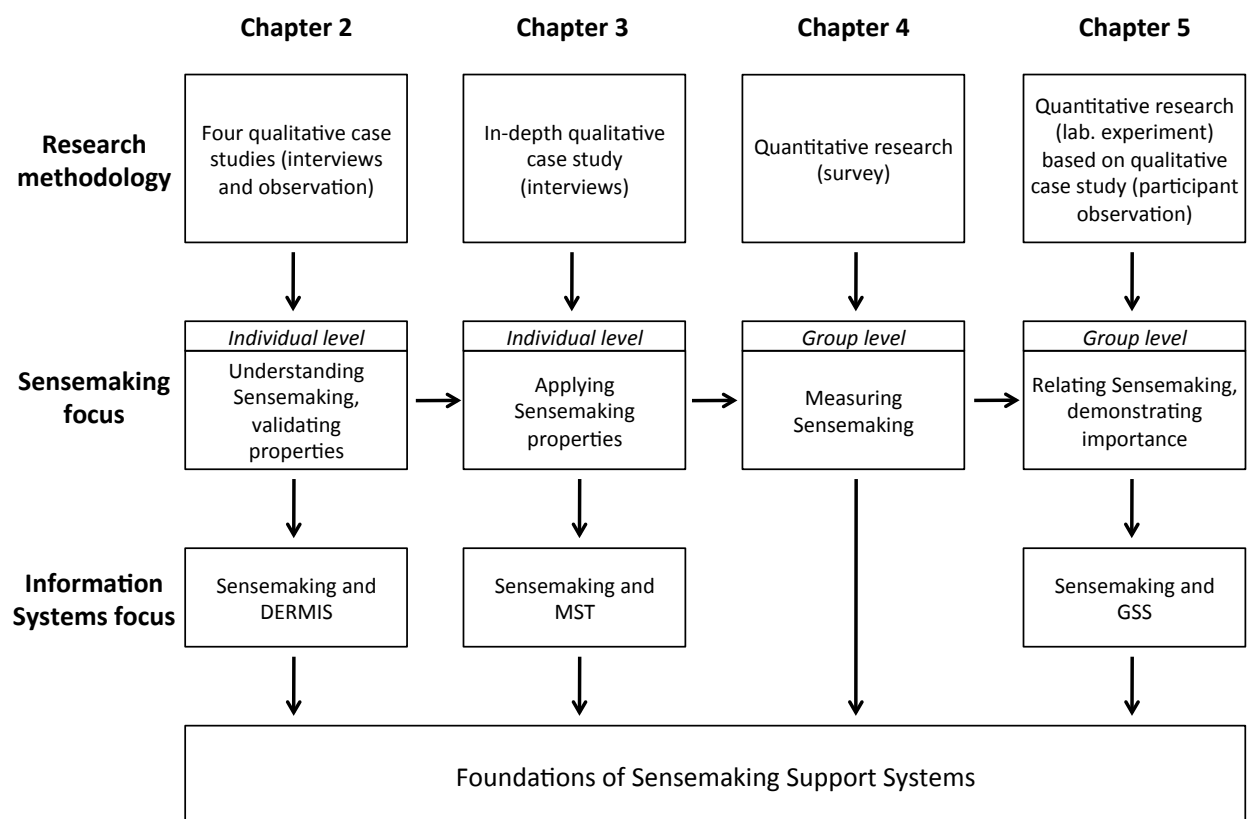


Figure 1.1: Research overview

report on four case studies we conducted in different crisis situations: (1) a case study of the sudden crisis of an airplane crash in the Barents Rescue Exercise, (2) a case study of the yearly recurring forest fires crises in Portugal, (3) a case study of the post-conflict European Union Police Mission (EUPM) in Bosnia and Herzegovina, and (4) a case study of humanitarian aid and development organizations that operate in a complex emergency in the Democratic Republic of Congo (DRC). We explore the difference between Sensemaking and decision making, two activities that are undertaken to cope with information processing challenges, and explore them in the first three case studies (in accordance with research question 1). In the fourth case study, we introduce the theory of Sensemaking as a lens to observe and analyze the information processing behavior of organizations, and we guide our analysis by the seven Sensemaking properties and examine whether we can observe these Sensemaking properties in humanitarian crisis response (in accordance with research question 2). We discuss design premises for crisis management IS and compare these to our findings from the four case studies (in accordance with research question 3).

In Chapter 3 we report in-depth on the case study conducted in the DRC, for which we conducted interviews among senior management of international aid and development organizations operating in the country's ongoing crisis situation. In this chapter we reintroduce concepts from Sensemaking in Media Synchronicity Theory (MST), and focus on how media should support synchronicity to fit communication needs when making sense of a humanitarian crisis situation. We examine the Sensemaking properties from a communications perspective and analyze our findings from the DRC to this newly developed model (in accordance with research question 4), and compare our findings to the synchronicity of media that is suggested to support conveyance processes for establishing an individual understanding (in accordance with research question 5).

Our focus in Chapters 2 and 3 is on the individual and intersubjective levels of Sensemaking. These are the levels at which the processing of information is mainly undertaken to reach an individual understanding, especially when cosmology episodes lead to a breaking down of generic subjectivity. In these chapters we have observed and identified Sensemaking qualitatively. In Chapters 4 and 5 we focus on group Sensemaking, the generic subjectivity level of Sensemaking, and take a quantitative approach.

In Chapter 4 we describe the approach we took to quantify and measure Sensemaking (in accordance with research question 6). The measurement of Sensemaking is a crucial prerequisite to investigating which type of IS support aids or inhibits Sensemaking, but has not been attempted previously. We discuss Sensemaking statements from theory which are most applicable to group Sensemaking in humanitarian crisis response, and construct a reliable scale with survey items to measure this.

In Chapter 5 we apply our group Sensemaking measurement scale to a specific humanitarian crisis response situation in which Sensemaking plays an important role: the needs assessment process. Due to the growing impact of natural hazards (United Nations, 2004) and subsequently the growing humanitarian needs, there is an even larger need for efficient and effective deployment of the scarce resources. Without accurate and timely information on the impact of the crisis and the humanitarian needs, humanitarian assistance might be targeting the wrong areas, providing the wrong relief items, and be

unnecessarily delayed, with disastrous consequences. Through a laboratory – hidden profile – experiment, grounded on our participant observation experiences in a humanitarian crisis response exercise (in accordance with research question 3), we investigate the effect of different types of group support and information processing demands on Sensemaking and information sharing (in accordance with research question 7), and demonstrate the importance of Sensemaking for a good performance in humanitarian crisis response teams (in accordance with research question 8).

Chapter 6 is an overall conclusion to the dissertation and answers all eight research questions and the problem statement.

Chapter 2

A Call for Sensemaking Support Systems in Crisis Management*

The noblest pleasure is the joy of understanding.

Leonardo da Vinci

In this chapter we focus on how actors cope with information processing challenges in crisis situations to understand better what type of Information Systems (IS) support is needed in these circumstances. We report on four case studies we conducted in different crisis situations: (1) an aviation crash in the Barents Rescue Exercise, (2) forest fires in Portugal, (3) the European Union Police Mission (EUPM) in Bosnia and Herzegovina, and (4) humanitarian aid and development organizations that operate in a complex emergency in the Democratic Republic of Congo (DRC). In the first three case studies we examine how information processing challenges of ambiguity, uncertainty, equivocality, and complexity are related to Sensemaking and decision making, and observe how actors deal with these information processing challenges (in accordance with research question 1). In the fourth case study we examine Sensemaking more in detail and specifically identify and validate the Sensemaking properties (in accordance with research question 2). We illustrate how in these four different crisis situations actors' information processing and decision-making behavior – identified through interviews and incidentally through observations – motivate critical design premises for crisis management IS (in accordance with research question 3). The answers to the research questions are formulated in Chapter 6.

This chapter is outlined as follows. In Section 2.1 we discuss several information processing challenges and how they relate to Sensemaking and decision making. We moreover review IS design requirements for crisis response. In Section 2.2 we discuss the case studies we conducted. For each case study we describe the methodology used, the findings related to how actors deal with information processing challenges, and the analyses of the find-

*This chapter is based to a great extent on Muhren, Van Den Eede, and Van de Walle (2008a) and Muhren and Van de Walle (2010a)

ings. In Section 2.3 we discuss implications for the design of crisis management IS, and in Section 2.4 we present our conclusions.

2.1 Information Processing Challenges and Support

Information related problems cause people to have difficulties in processing information in crisis situations. Often the terms uncertainty, complexity, ambiguity and equivocality are used in an attempt to stress the “difficult circumstances” people have to cope with. However, these terms are mostly used interchangeably, without exactly describing what is meant. Zack (2007) distinguished these four terms according to two dimensions: the nature of what is being processed, and the constitution of the processing problem.

The nature of what is being processed is either information or frames of reference. With information we mean “observations that have been cognitively processed and punctuated into coherent messages” (Zack, 2007). In contrast, frames of reference (Choo, 2006, p.108) are the interpretative frames which provide the context for creating and understanding information. There can be situations in which there is a lack of information or a lack of a frame of reference, or too much information or too many frames of reference to process.

Table 2.1 shows a breakdown into two dimensions, leading to four different types of information processing challenges (Zack, 2007): uncertainty, complexity, ambiguity and equivocality. We describe them briefly below.

Table 2.1: Information processing challenges (adapted from Zack (2007))

	Information	Frame(s) of reference
Lack of...	Uncertainty	Ambiguity
Variety/diversity of...	Complexity	Equivocality

Uncertainty is a situation in which there is not sufficient information possessed by the organization to perform the task (Daft and Lengel, 1986; Galbraith, 1977). *Complexity* is the second challenge, and arises when there is more information than one can easily process (Zack, 2007). Although information related problems are not the only type of problems that lead to complexity, this narrow definition suffices for our present focus on information-related processing challenges. When there is a situation in which one does not have a framework for interpreting information, there is *ambiguity* (Zack, 2007). Finally, *equivocality* – or confusion – is a situation in which one has several competing or contradictory frameworks (Daft and MacIntosh, 1981). Ambiguity and equivocality may at first sight seem to be synonymous terms, but they are used throughout literature to distinguish between unclear meaning (ambiguity) and the confusion created by two or more meanings as in a pun or equivocal (equivocality) (Weick, 1995, p.92).

The four information processing challenges are not mutually exclusive, but often exhibit a natural hierarchy of difficulty in practice. Ambiguity is the most difficult

challenge to overcome, since it involves developing a frame of reference when none is available. When people negotiate their interpretations and share their understandings, a situation of equivocality can arise as there are multiple conflicting frames of reference. There is a balance needed for on one side creating new frames of references and on the other side reducing the frames. Once an appropriate frame is constructed, the situation may reveal itself to be uncertain, complex, or both. This will determine whether a strategy of information seeking or information reduction should be adapted.

Next (Subsection 2.1.1), we use this distinction between the different information processing challenges to contrast Sensemaking and decision making with each other. In Subsection 2.1.2 we review IS design requirements for supporting crisis actors in dealing with their information processing challenges.

2.1.1 Sensemaking versus decision making

Decision making is traditionally viewed as a sequential process of problem classification and definition, alternative generation, alternative evaluation, and selection of the best course of action (Simon, 1976). This process is about strategic rationality, aimed at reducing uncertainty (Daft and MacIntosh, 1981; Weick, 1993). Uncertainty can be reduced through objective analysis because it consists of clear questions for which answers exist (Daft and Lengel, 1986; Weick and Meader, 1993). Complexity can also be reduced by objective analysis, as it requires restricting or reducing factual information and associated linkages (Zack, 2007).

On the contrary, Sensemaking is about contextual rationality, built out of vague questions, muddy answers, and negotiated agreements that attempt to reduce ambiguity and equivocality. The genesis of Sensemaking is a lack of fit between what we expect and what we encounter (Weick and Meader, 1993). With Sensemaking one does not look at the question of “which course of action should we choose?”, but instead at an earlier point in time where users are unsure whether there is even a decision to be made, with questions such as “what is going on here, and should I even be asking this question just now?” (Weick and Meader, 1993). This shows that Sensemaking is used to overcome situations of ambiguity. When there are too many interpretations of an event, people engage in Sensemaking too, in order to reduce equivocality.

Sensemaking is concerned with making things that have already happened meaningful (Boland, 2008) and is more than problem definition, as Weick and Meader (1993) explain: “to label a small portion of the stream of experiences as a “problem” is only one of many options. The stream could also be labeled a predicament, an enigma, a dilemma, or an opportunity. Each of these labels has a different implication for action. If it is a problem, then solve it; but if it is a predicament, then accept it; if it is an enigma then ignore it; if it is a dilemma then define it anyway; and if it is an opportunity then exploit it. To call something a problem is the outcome of Sensemaking”.

People usually enhance their Sensemaking efforts after a sudden loss of meaning, when they experience a diffuse sense of unease that perhaps something needs to be done, al-

though no one can say for sure. People then “must make sense of an uncertain situation that initially makes no sense” (Schon, 1983, p.40) , and try to shape and give definition to the decision context by processes of Sensemaking (Weick and Meader, 1993). As we have discussed previously in Subsection 1.2.2, Sensemaking differs from interpretation as Sensemaking “is about the ways people generate what they interpret” (Weick, 1995, p.13).

Just as the information processing challenges from Table 2.1 are not mutually exclusive, Sensemaking and decision making cannot be separated but instead operate simultaneously. Meaning must be established and then sufficiently negotiated prior to acting on information (Zack, 2007): Sensemaking shapes events into decisions, and decision making clarifies what is happening (Weick and Meader, 1993).

The previous discussion does not imply that dealing with information challenges is not important for Sensemaking. It is not possible to separate the two activities of coping with information challenges and interpretation challenges. However, the main activity of Sensemaking is ascribing meaning to what is really happening and not gathering information on a situation. More information does not automatically lead to better Sensemaking (Klein et al., 2007). The central problem requiring Sensemaking is mostly that there are too many potential meanings, and so acquiring information can sometimes help but often is not needed. Instead, triangulating information (Weick, 1985), socializing and exchanging different points of view, and thinking back over previous experiences to place the current situation into context, as the retrospection property showed us, are a few strategies that are likely to be more successful for Sensemaking and will be further explored in the remainder of this dissertation.

We are now able to make a clear distinction between decision making and Sensemaking. Decision making is about coping with information processing challenges of uncertainty and complexity by dealing with information, whereas Sensemaking is about coping with information processing challenges of ambiguity and equivocality by dealing with frames of reference. This information processing distinction between decision making and Sensemaking has – to the best of our knowledge – not been made previously in literature. We will apply this dichotomy in the discussion of the case studies in Section 2.2.

2.1.2 Information systems

The problems of managing information and managing frames of reference are “tightly linked in a mutually interacting loop” and require integration of formalized decision-making procedures and informal socialization and shared understanding, managing information, and managing the systems that provide it (Ribbers et al., 2002; Zack, 2007). In Section 1.3 we discussed the limitations of the current design of IS. IS have been generally designed to overcome the information problems from Table 2.1. Problems of interpretation and the creation and management of frames of reference, which aids Sensemaking, have generally not been taken into account when designing IS. In this chapter we investigate how the information processing behavior of actors operating in different crisis circumstances can be aligned with the design of IS. We base our study on Turoff et al. (2004)’s important work on the design of crisis management information systems, in which they propose necessary

underlying Dynamic Emergency Response Management Information System (DERMIS) premises.

Turoff et al. (2004) carefully examined the system design requirements for a DERMIS, an information system designed to support the response to major crises. In their article, they examined the historical experiences and literature associated with an early system that was utilized for 15 years in the federal government to handle national emergencies, and they integrated this with current literature and considerations to propose the requirements for a new generation of DERMIS that go beyond what is currently available.

In addition to training and simulation and role-based user requirements, DERMIS design premises focus on information and decision making, as summarized¹ in Table 2.2. These DERMIS design premises refer to the acute *response phase* of an emergency and therefore illustrate the support IS can provide to the teams actively involved in the response to a crisis (Landgren, 2005; Van Den Eede et al., 2006; Van de Walle and Turoff, 2007). While the focus in this chapter is broad and not only on the response but also on the preparedness phase – this rather eerie phase of continuous caution and anticipation for the next acute emergency outbreak – the DERMIS design premises remain highly relevant (Van de Walle and Turoff, 2008). Indeed, during the preparedness phase, organizations (a) focus on information gathering (DERMIS design premise 1), (b) try to obtain information from different sources (design premise 6), (c) review and update where needed their organizational crisis memory (design premise 2), (d) verify the scope and nature of the crisis (design premise 4) and the validity of information (design premise 5) through intra- and interorganizational coordination mechanisms (design premise 7), and (e) try to adapt themselves to this changing situation (design premise 3).

In the following section we discuss four case studies we conducted in different crisis situations, in which we examined how people handle and process information in crises to understand how supporting IS should be designed.

¹For a more detailed description of the DERMIS design premises, we refer the interested reader to Turoff et al. (2004)'s original work.

Table 2.2: DERMIS design premises (Turoff et al., 2004)

DERMIS design premise	Explanation of the design premise
Design premise 1: Information focus	Those who are dealing with a crisis are flooded by information. Therefore, the support system should carefully filter information that is directed towards actors. However, they must still be able to access all (contextual) information related to the crisis as the information elements, which are filtered out by the system, may still be of vital importance.
Design premise 2: Crisis memory	It is important that the system is able to log the chain of events during a crisis without imposing an extra workload on those involved in the crisis response. This logged information can be used to improve the system for use in future crises, but it can also be used to analyze the crisis itself.
Design premise 3: Exceptions as norms	Due to the uniqueness of most crises, usually a planned response to the crisis cannot be followed in detail. Most actions are exceptions to the earlier defined norms. This implies that the support system must be sufficiently flexible to allow reconfiguration and reallocation of resources during a crisis response.
Design premise 4: Scope and nature of crisis	Depending on the scope and nature of the crisis, several response teams may have to be assembled with members providing the necessary knowledge and experience for the teams' tasks. Special care should also be given to the fact that teams may operate only for a limited amount of time and then transfer their tasks to other teams or actors. The same goes for individual team members who may, for example, become exhausted after an amount of time.
Design premise 5: Information validity and timeliness	As actions undertaken during crises are always based on incomplete information, it is of paramount importance that the emergency response system makes an effort to store all available information in a centralized database. Thus, those involved in the crisis response can rely on a broad base of information, helping them making decisions that are more effective and efficient in handling the crisis.
Design premise 6: Free exchange of information	During crisis response, it is important that a great amount of information can be exchanged among stakeholders so that they can delegate authority and conduct oversight. This, however, induces a risk of information overload, which, in turn, can be a risk to the crisis response effort. The response system should somehow protect participants from information overload.
Design premise 7: Coordination	Due to the unpredictable nature of a crisis, the exact actions and responsibilities of individuals and teams cannot be determined ex ante. Therefore, the system should be able to support the flow of authority directed towards where the action takes place (usually on a low hierarchical level), but also the reverse flow of accountability and status information upward and sideways through the organization.

2.2 Case Studies

We conducted four exploratory crisis management case studies (Muhren et al., 2008): the sudden crisis of an airplane crash in the Barents Rescue Exercise, the yearly recurring crises of forest fires in Portugal, the post-conflict state building EUPM in Bosnia and Herzegovina (BiH), and the complex emergency in the DRC. We selected these case studies on grounds of their differing crisis characteristics, as we wanted to investigate how people handle and process information and make sense in a broad spectrum of crisis management situations. In Table 2.3 we show how these case studies differ from each other on six aspects of crisis management.

Table 2.3: Taxonomy of crisis management case studies

	Case study 1: Barents Rescue Exercise, Finland	Case study 2: Forest fires, Portugal	Case study 3: EUPM, BiH	Case study 4: Complex emer- gency, DRC
Crisis type	Accident	Natural disaster	Conflict	Conflict
Operations	Response	Prevention & response	Recovery	Prevention, response & recovery
Timing	In casu	Ex ante & in casu	Ex post	Ex ante, in casu & ex post
Focus	Operational	Strategic	Operational	Strategic
Time span	Short	Ongoing, long term	Medium term	Ongoing, long term
Predictability	Sudden	Expected	Expected	Expected

In Subsection 2.2.1 we describe the common methodology used. Next, (Subsections 2.2.2, 2.2.3, 2.2.4, and 2.2.5) we describe the four case studies: an introduction to each case study, how we conducted it, the findings from the case study, and a discussion of the findings. For the first three case studies, the findings are organized according to the nature of the processing of information: the dealing with information to reduce uncertainty and complexity, and the dealing with frames of reference to reduce ambiguity and equivocality. Literal quotations from interviewees are indicated with quotation marks. As our focus in the last case study is on the identification and validation of the Sensemaking properties, the analyses of the findings are organized according to the seven Sensemaking properties (as introduced in Subsection 1.2.1).

2.2.1 Research methodology

For these case studies we used an interpretive research methodology, and conducted in total 37 interviews with a common approach and research aim. Appendix A (page 144)

provides an overview of all interviews we conducted. Interpretive research attempts to understand phenomena through the meanings that people assign to them (Orlikowski and Baroudi, 1991). A critique often heard with regard to case study research – and other qualitative methods for that matter – is that they ostensibly provide for more room for the researcher’s subjective and arbitrary judgment than other methods. Hence, they are seen as less rigorous than quantitative research methods. Flyvbjerg (2006) counters this critique and argues that “the case study has its own rigor, different to be sure, but no less strict than the rigor of quantitative methods. The advantage of the case study is that it can ‘close in’ on real-life situations and test views directly in relation to phenomena as they unfold in practice”. Interpretive methods of IS research take into account the context in which the information system is used with the particularity that it also acknowledges the mutual interaction between the system and its context. In order to succeed in the opening up of these mutual interactions, the researcher has to interact with the research participants. Klein and Myers (1999) state that the “data are not just sitting there waiting to be gathered, like rocks on the seashore”. Data are produced in a social interaction of the researchers with the participants.

For our research design, we drew on Walsham (1995a,b, 2006) and Klein and Myers (1999) who have provided comprehensive guidelines on how to conduct interpretive case study research in the IS domain, and used a semistructured interview technique as primary evidence generation mechanism (Palvia et al., 2003). On the practical level this shows itself throughout our research by means of a colorful interviewing style with which we stimulated our respondents to answer difficult questions related to the Sensemaking properties (Muhren et al., 2008b), amongst others by using statements, dichotomies, metaphors, and dilemmas, relying heavily on examples and anecdotes, and calling upon their imagination to find out the bottom-line. In our interpretive case studies we adjusted our style to the respondent, such as to his/her language, world view, professional experience, and personality.

The interviews were semi-structured, in the sense that we knew which topics to touch upon and had a list of the general points we wanted to find out, related to the seven Sensemaking properties, but adjusted the questions to how the interview was evolving. Permission for tape recording was granted for all interviews except for one; only notes were taken at the interview in which the respondent was not comfortable with the use of a tape recorder. Confidentiality was guaranteed in all interviews.

We supplemented data and understanding of the case studies with other types of field data, such as reports, background stories on various websites, press articles, brochures, and informal interaction at the sites of the case studies. After the initial data analysis and write-up of our observations, we sent a report of the case studies (Muhren et al., 2008) to all interviewees. Three interviewees responded and validated our interpretations.

2.2.2 Case study 1: Barents Rescue Exercise

Barents Rescue is a series of field training exercises which are organized and conducted by the countries within the Barents Euro-Arctic Council (BEAC): Norway, Sweden, Finland,

and Russia. The Barents Rescue 2007 Exercise was held in October 2007 in Saariselkä and Ivalo, located in the Northern part of Finland. The exercise aimed to facilitate communication, coordination, and cooperation between countries and civil-military services that may be involved in crises relevant to the Barents region. The project consisted of a series of planning conferences, training events, and exercises, of which the Barents Rescue Exercise in October 2007 was the final and main event.

There are several challenges to crisis response operations in the Barents region. We mention four of them: big distances between cities, limited infrastructure, limited resources for rescue operations due to the scarce population, and severe climate conditions in winter. For this reason, it is important that the countries in the region plan on how to join forces when responding to a crisis. The Barents Rescue Exercise was aimed at training such cooperation and improving crisis preparedness.

The scenario for the exercise was an aviation accident. A British aircraft executed an emergency landing in the uninhabited areas of the Inari municipality. The more than 200 passengers were mainly tourists from the United Kingdom. The reason for the crash was not immediately clear, but it was very likely that many passengers were injured or deceased. The scenario involved different stakeholders from the BEAC countries, such as alarm centers, national rescue services, hospitals, the military, private companies, and voluntary organizations.

The exercise included three phases with different approaches to crisis management. The first phase, the *alarm exercise*, was aimed at exercising the alarming and gathering of possible resources in the Barents region in case of a major crisis. The second phase, the *table top exercise*, was aimed at exercising the practical response in the crisis area, consisting of a command post exercise, table top exercise, and exercise with utilizing virtual tools. The third phase, the *field training exercise*, was aimed at training the capabilities of organizations and agencies involved in the direct response to a crisis, both on the operational level and on the strategic level.

Case study implementation

In October 2007 we² traveled to the Northern part of Finland for the Barents Rescue Exercise. We conducted four interviews with key people involved in the crisis response operation: one person working at the On Site Operations Coordination Center (OSOCC), one person working at the Local Emergency Management Authority (LEMA), one person working at the On Site Command Center (OSC), and one person in charge of leading the medical team. An overview of the interviews is provided in Appendix A.

Besides these interviews, we obtained a good overview of how the actors handle and process information in the exercise through observations (cf. Angrosino, 2005). As the table top exercise and the field training exercise were each organized on one location, we could observe how all the actors dealt with the crisis. These observations were used for the interviews, as we could ask specific questions on the actions of the observed people

²Gerd Van Den Eede and Willem Muhren

and what had happened in the exercise. The Barents Rescue Exercise provided a good opportunity for us to observe a crisis on the operational level, as it is difficult to observe a crisis in a real-life situation.

Next, we present our findings on how the crisis actors involved in the Barents Rescue Exercise deal with information processing challenges according to the framework previously presented in Table 2.1. We will first discuss our findings on how actors deal with the challenges related to *information* – uncertainty and complexity – and thereafter discuss how actors deal with the challenges related to *frames of reference* – ambiguity and equivocality.

Case study findings: dealing with challenges of information

We observed several information problems in the Barents Rescue Exercise, all leading to a delay in the crisis response. There were problems of conflicting information when the air traffic control and the rescue services labeled the accident site with two different geographical coordinates. Information often arrived late in the alarm exercise, as the primary communication technology that was used was the fax, the most commonly used tool at the time the procedures were put in place. Other unnecessary delays were caused in the field because it was not clear which organization was in charge of the rescue operation. Moreover, not all actors were informed about the Emergency Rescue Center in Tromsø as a contact point for the response operation. Another factor delaying the response was the information provision to the medical team. After the initial alarm, it took 90 minutes before the medical team received the first information about the victims. The medical team was only able to determine the kind of assistance that was needed after this information was received.

Actors deal with these information problems in different ways. People indicated to have preferences concerning the level of detail of information that is useful to have. Although most interviewees clearly stated that more detail was better for them, there were also cases in which actors argued that anything more than essential information was not needed and in fact distracted them from their job.

People also had different ways for making sure they were communicating as effectively as possible. For example, one actor started handling the crisis by listing his key contact persons and phone numbers in order to prepare himself for information exchanges in the upcoming hectic circumstances.

What happened in practice when people communicated in the crisis, was that messages were double-checked to make sure that they arrived, as illustrated in radio communications by the recipient repeating the main words.

The interviewee who was working in the OSC said that “you are forced to trust the people with whom you are exchanging information, no matter who is on the other side” when responding to a crisis. He felt that there is not much time to think about whether the information received from others is right or wrong, and he therefore had to act on the information that was available.

For the people in the OSOCC, it was important to receive information on what is

happening on a continuous basis: “We need to get the key cards, to keep being informed”. The OSOCC and LEMA were operating in two separate but adjacent rooms. A liaison officer of LEMA was appointed to brief the people in the OSOCC regularly on what was happening. This briefing was however not sufficiently frequent, especially since LEMA was quite busy. Moreover, the people in the OSOCC did not use any system to receive information and communicate with the LEMA.

Case study findings: dealing with challenges of frames of reference

Some people identified experience to be a *helpful* resource for crisis response while others felt it to be *essential*: “From your experience you cannot remember everything, but many things stay in the back of your head and become a routine.”

For one key actor it was important to create time to think about the situation: “I read the documents and think about what’s next. And if there is too much noise, I go perhaps out, take a cup of coffee, and smoke a cigarette. Because when it’s so hectic, you have to clear your mind and think about what’s going on.”

Most of the interviewees indicated that they value effectiveness over efficiency when responding to a crisis. For example, they would request more resources than deemed absolutely necessary, just to be sure to have enough.

In the alarm exercise, actors had different expectations of each other. For example regarding the procedure to follow, Finnish actors expected a swift response from other countries while Norwegian actors took their time to find out how many resources were needed and available.

The comparison of frames of reference on the strategic level by exchanging points of view and understanding of the crisis was hampered because most of the time the OSOCC and LEMA worked independently.

Language was an issue of concern in this international exercise. As responders cannot use their native language when cooperating with responders from other countries, it was difficult for them to choose the right words to use. Culture is also important, as an interviewee emphasized: “We [Finnish people], together with the Swedes and Norwegians, think in the same way and have the same kind of picture in mind all the time. We have the same kind of systems [structures] in place, and we understand each other. But with the Russians it’s a bit harder.”

Discussion of the findings

The initial response to an airplane crash should be a rapid response, as surviving passengers need immediate medical aid. We however observed two types of challenges concerning information (Table 2.1) delaying the response. First, we observed problems of *uncertainty* – a lack of information: the alarm center could not inform actors swiftly due to an outdated alarm procedure by fax, contact points and focal points for the response operation were unknown to many actors, and the medical team received information on the victims far too late. Moreover, the information exchange between LEMA and OSOCC was not good. In

the future this can be avoided by having LEMA and OSOCC in the same location, or by using shared IS. In this case the people in the OSOCC are not dependent on briefings but can actively follow what is going on. Second, we observed problems of *complexity* when for instance actors had to determine the accident site, and the IS that were used by various actors were not interoperable.

Actors tried to cope with uncertainty and complexity in different ways. Interviewees indicated to have different preferences concerning the level of detail of information, and consequently either seek more detailed information or refrain from this level of detail. Actors take precautionary measures against complexity by organizing information in certain ways, double checking information they receive to avoid having conflicting information, and acting on uncertain information as it is the only information they have.

Although situations of ambiguity and equivocality are more difficult to observe, these two types of challenges concerning frames of reference (Table 2.1) revealed themselves in the interviews. First, concerning *ambiguity*, interviewees indicated that when they have no accurate frame of reference, they rely on their experience, take time to think about the situation, and act according to the (inaccurate) frame of reference they have. Second, we observed that it was difficult for the actors to cope with *equivocality*. Communication and information exchange between actors was not sufficient, due to physical separation and lack of appropriate systems to support this. Also the international context of response hampered the discussion and exchange of frames of reference, as actors had different cultural backgrounds and were speaking different languages.

In Section 2.3 we discuss the implications of how these actors deal with challenges of information and frames of reference for the design of crisis management IS.

2.2.3 Case study 2: Forest fires in Portugal

Forest fires are a great concern for Portugal, as more than a quarter of the country is covered by forests, and droughts in summertime increase the likelihood of such crises. In recent years Portugal has been facing extremely hot and dry summers, with highest peaks in 2003 and 2005. The fire risk in Portugal has been increased by changes in land use practices. Rural exodus has left a large area of land uncultivated, where combustible materials can now unnoted trigger big fires when droughts occur.

The National Authority for Civil Protection (Portuguese acronym ANPC) has the primary role in planning, coordinating, and implementing the Civil Protection policy. The ANPC is a central operational service under the direct administration of the Ministry of Interior. The ANPC maintains its own operational structure, the National Command for Relief Operations, which ensures the operational command in terms of relief operations and the integrated operational command of all the fire brigades in accordance with the legal system. The Integrated System for Relief and Protection Operations is a set of structures, norms, and procedures which ensures that all civil protection agents act under a sole command. This integrated system aims at responding to (imminent) crisis situations.

The Portuguese State does not have its own fire brigades. The great majority of the fire

brigades are volunteer fire fighter associations; others belong to the city councils and private companies. The Portuguese Forest Services play an important role in the management of the forests in Portugal, especially in mapping the risks of hazards and in educating people on how to prevent forest fires.

In 2003, 2004, and 2005 Portugal could not cope with the forest fires themselves, and therefore requested outside assistance through the European Commission (EC)'s Community Civil Protection Mechanism. The Community Civil Protection Mechanism was established in October 2001 and is an operational instrument designed to enhance preparedness and to mobilize immediate civil protection assistance in the event of crises. It can be activated in case of natural hazards and man-made disasters by any country in the world, after which one or more of the thirty participating states – the European Union (EU) member states as well as Liechtenstein, Norway, and Iceland – will try to offer their assistance. The mechanism is coordinated by the Monitoring and Information Center (MIC) of the EC in Brussels.

Case study implementation

For the Portuguese forest fires case study we conducted interviews using the previously discussed interpretive approach, interviewing six people who are involved in managing and preventing forest fires in Portugal, either on the national level or on the international level through the Community Civil Protection Mechanism. An overview of the interviews is provided in Appendix A. The interviews were aimed at finding out how these actors handle and process information related to the Portuguese forest fires.

In December 2007 we³ traveled to Lisbon to interview two people working at the ANPC and two people at the Portuguese Forest Services, and had the opportunity to observe the operations center of the ANPC. We⁴ conducted two follow-up interviews in February 2008 in Brussels: one interview with a person working at the EC, Directorate General (DG) for the Environment, who also demonstrated us the MIC, and one interview with a person working at the Civil Protection Unit of the EU's Council Secretariat.

Next, we present our findings on how the crisis actors involved in the Portuguese forest fires deal with information processing challenges according to the framework previously presented in Table 2.1. We will first discuss our findings on how actors deal with the challenges related to *information* – uncertainty and complexity – and thereafter discuss how actors deal with the challenges related to *frames of reference* – ambiguity and equivocality.

Case study findings: dealing with challenges of information

The Portuguese Forest Services are mainly focused on preventing forest fires. They produce two kinds of fire hazard maps and share these with the district level and the ANPC: one structural, not very detailed map with a large pixel size, and one map with a smaller pixel

³Willem Muhren

⁴Meeri-Maria Jaarva and Willem Muhren

size. The latter is better suited for teams on the ground and indicates the hazards in summer; in winter it is used to find areas where the authorities can conduct “prescribed firing”, which are techniques to manage fuel. Historical information on where the forests fires took place is important information for producing these maps. Depending on the tree species, it takes on average five years for a forest to become a potential “problem situation” when forest fires are a substantial risk, but it takes many more years for a forest to return to their pre-fire state. The Portuguese Forest Services experience problems of acquiring up-to-date information for producing the fire hazard maps, as these often have to be bought and land-use data is very expensive.

Both detection of forest fires and first response to forest fires are important, as the difficulty of fighting such fires increases nearly exponentially in time. Forest fires can be detected in three ways: (1) by somebody from the population calling 117 (the dedicated forest fire emergency phone number) or 112 (the normal emergency phone number), (2) by a surveillance post, or (3) by a surveillance brigade. The ANPC is responsible for informing the population, the people who work for civil protection, the media, and the national and district level command structure. The district command for relief operations is responsible for the deployment of means, both terrestrial and aerial, and the first intervention. If they do not succeed, or if the fire crosses the district level, the ANPC is responsible for the enlarged combat situation. The ANPC then sends more resources to the field, which can be requested from other districts.

When the crisis is overwhelming and national resources are insufficient, the minister – advised by the national commander – can activate the Community Civil Protection Mechanism by sending a message to the MIC in Brussels. The ANPC is permanently connected to the Common Emergency Communication and Information System (CECIS) of the MIC. CECIS allows for sharing of current information on the situation as well as identification of what is needed. Countries can also indicate whether they are able to provide assistance or not.

Daily briefings take place at the ANPC in summer on the general hazard situation of the country with representatives from the major stakeholders. The National Guard and the armed forces have permanent liaison officers stationed at the ANPC. In the case of a severe crisis, liaison officers from other civil protection agencies are present at the ANPC, such as officers from the forest department, the maritime authority, the police, the medical services, and the meteorological institute: “In the daily briefings we bring information from all the agents who share responsibility in terms of civil protection.” At the end of these briefings, the ANPC provides all actors with a summary of these briefings in writing. The national commander takes decisions according to the information shared and the analysis conducted in the meeting, for example, on whether to increase the readiness level or to pre-mobilize resources.

The ANPC mainly uses the media to communicate with the population and other external parties. When a threatening situation arises, the ANPC sends out an alert and the key players from the media come to the office where they are briefed. The media outlets then disseminate the message to the citizens, including any measures that should be taken. The ANPC also organizes a press conference every week on what is happening

and what the expectations are for the following week. In severe crisis situations there is a daily press conference.

The ANPC displays information for the citizens on their website, such as information on where current fires are located and how many fire fighters are working in the area. The website also advises people on what to do for each level of forest fire risk. The people at the ANPC realize that it is important to provide accurate information: “We cannot always tell people that tomorrow will be the worst day.”

There is much redundancy in the sharing of information. When civil protection actors send out a message, they make sure it arrives by using as many means as possible. At the ANPC, people are updated on the situation by text messages, and senders usually immediately call to check whether the message has been received and read. When the Community Mechanism for Civil Protection is activated, fax messages are sent and phone calls are made to other countries besides the formal request through CECIS: “In a crisis situation this is quite normal as you want to make sure the message gets to the person.”

Case study findings: dealing with challenges of frames of reference

Forest fires in Portugal do not only happen during the summer, they also occur in winter-time. Winter fires are good if they are controlled, since what burns at that time cannot burn in summer when the fires are mostly not controllable. However, the concept of “good fires” is new and generally unknown by the population. It therefore is important to inform the people that fires during winter are not bad if they are managed appropriately. The Portuguese Forest Services promote this idea on their website and have launched a campaign on television, radio, and in newspapers. Another campaign highlighted that people should not light fires near forests during summer, and that they should clear all combustible materials. Besides these nation-wide campaigns, the Portuguese Forest Services have engaged in direct contact with local shepherds, farmers, and forest owners to try to change their behavior and spread the word that not all fires are bad.

The ANPC’s main target is currently to educate people. They do this together with big companies such as supermarket chains. One initiative included printing the phrases “Portugal without fires depends on everyone” and “You should not use fire on a hot day” on the supermarket’s plastic bags. The ANPC has also been advertizing in football stadiums and on football shirts, and has broadcasted their campaigns on television and advertized in newspapers. “You have to give good and correct information to your population, otherwise you can have situations as in 2003, 2004, and 2005”, one interviewee said. It has been successful until now: the number of ignitions has been reduced since the start of these campaigns.

There have been instances in which the forest fire situation was under control, but people started to panic as images of the fire were aired on television. One interviewee stated that the best way to prevent these kinds of situations is to cooperate actively with the media.

To aid interpreting new information on the hazard situation, the ANPC visualizes information about the major incidents that are occurring in the country on a Geographic

Information Systems (GIS) based map. There is a special screen on which the forest fire situation is projected.

After each big crisis in Portugal, the ANPC invites all the actors that were involved in the response to discuss the process, what was done and what worked or did not work. These lessons learned are then incorporated into their procedures.

The MIC has the overall European helicopter view on civil protection. The mechanism can facilitate and give an “educated hint” as to which country to help, but in the end the countries themselves decide on whether they want to provide or accept assistance. Countries do not always accept assistance, because the help that is offered may not be exactly what they want, or it comes with a price they are not willing to pay.

Notably the use of language in CECIS is not standardized. This sometimes causes problems in interpreting what is meant by a request or an offer, and has resulted in countries assisting with resources that were not of use in that crisis situation.

“Nothing helps more in emergency situations than people knowing each other”, many interviewees mentioned. The Community Mechanism for Civil Protection and the MIC bring together people from all 30 countries for events like training sessions, workshops, common exercises, and meetings. Through these types of interaction people become more familiar with the realities of the other countries: “The more you exchange information, the more you know where and how to target your request for assistance. And the better you make your request, the better you get answered.”

Discussion of the findings

In summer the ANPC needs to obtain accurate and timely information on the actual situation of the forest fires, and needs to provide the actors on the ground and the citizens with information concerning the forest fires. As forest fires pose a continuous threat to the country, there are good systems in place for obtaining and providing this information, such as the different ways a forest fire can be reported, daily briefings with all key response actors, and good cooperation with the media. We observed two types of challenges concerning information (Table 2.1) delaying the response.

The first challenge we discuss is related to *complexity*. The importance of timely and accurate information is evident in the behavior of actors when communicating through the Community Mechanism for Civil Protection, as redundant information exchanges take place to make sure that recipients have read a message and understood it correctly. This however might lead to a situation of complexity, as people receive many notifications on different communication media and might lose track of which message is new for them and which message is part of a “reminder”.

Second, we observed the challenge of *uncertainty*. With such yearly recurring crises, the actors have chosen for a strategy of prevention rather than only response. The Portuguese Forest Services play a leading role in this by mapping the risk of forest fires in the different areas. They however experience problems of uncertainty as they have difficulties in obtaining all relevant information for such maps. In the response phase to a forest fire, informing citizens is important in Portugal’s. The Portuguese Forest Services cooperate

with the ANPC for prevention campaigns, the ANPC provides information on forest fires on their website, and there are press conferences in summertime. All these activities are aimed at removing uncertainty that citizens face.

We also observed the two types of challenges concerning frames of reference (Table 2.1) when dealing with the Portuguese forest fires. First, some campaigns in Portugal were aimed at removing *ambiguity* by providing a frame of reference for citizens to make sense of what is happening. For example, the concept of “good fires” was unknown to the majority of people, but after the campaign citizens would better understand the fires that occur in wintertime. Such educational campaigns could also prevent interpretation problems leading to panic, such as the broadcast of fires on television at a time when fires are under control.

Second, we observed that the main strategy to cope with *equivocality* is to socially mix and engage in discussion. After a crisis, the key actors discuss their understanding of what happened and what went wrong, and try to create a common frame of reference which is then incorporated into their procedures and used to deal with the next crisis. Moreover, one interviewee mentioned the importance for actors to socially mix between different country representatives, as it helps civil protection actors to understand the situation in other countries, how they respond, their concerns, etc. This is useful for future collaboration and assistance, as the other actors’ frames of reference are then better understood.

In Section 2.3 we discuss the implications of how these actors deal with challenges of information and frames of reference for the design of crisis management IS.

2.2.4 Case study 3: European Union police mission in Bosnia and Herzegovina

Since 1991, the EC has set aside more than €2.5 billion to support Bosnia and Herzegovina with public administration reform, justice and home affairs-related issues, and improvement of the investment climate as key target areas. Police reform has been one of the main obstacles to Bosnia and Herzegovina’s integration in the EU.

International efforts to reform the Bosnian police force started immediately after the peace agreement when the United Nations (UN) led International Police Task Force (IPTF) was deployed. The IPTF comprised more than 2,000 international police officers from 43 countries.

On January 1st 2003, the EU launched the EUPM in Bosnia and Herzegovina. It was the first mission initiated under the European Security and Defense Policy (ESDP), initially intended to cover a three-year period and included around 500 police officers from more than thirty countries. On July 1st 2005 the EC concluded that police reform was the single remaining obstacle to the Stabilization and Association Agreement. Following an invitation by the Bosnian authorities, the EU decided to establish a continued and refocused EUPM of 200 international staff members and a mandate of two years, until the

end of 2008. The EUPM supports the police reform process and continues to develop and consolidate local capacity and regional cooperation in the fight against organized crime.

In addition to the EU Police Mission, the EU has an European Union Special Representative (EUSR) and a military crisis management mission, European Union Force (EUFOR) Althea, in Bosnia and Herzegovina. The EUSR is in charge of assuring the coherence of the ESDP activities. The EUSR can offer political advice to the EUFOR amongst others regarding organized crime, and facilitates coordination between Brussels and Sarajevo. The EUFOR also has a paramilitary police force under its command. The EUPM however is the lead in the coordination of policing aspects of the ESDP efforts in the fight against organized crime.

Case study implementation

In April 2008 we⁵ traveled to Sarajevo and conducted a total of twelve interviews using the interpretive approach. An overview of the interviews is provided in Appendix A. We conducted interviews with EUPM people from the general management, EU Coordination Office, Security Department, and Press and Public Information Department. Moreover, we conducted interviews with people who are directly or indirectly involved with the work of the EUPM: representatives of the EC Department Police Projects, EUFOR, EUSR, Canton Sarajevo Police Department, Organization for Security and Co-operation in Europe, and the Populari think-tank.

Next, we present our findings on how the crisis actors involved in the EUPM deal with information processing challenges according to the framework previously presented in Table 2.1. We will first discuss our findings on how actors deal with the challenges related to *information* – uncertainty and complexity – and thereafter discuss how actors deal with the challenges related to *frames of reference* – ambiguity and equivocality.

Case study findings: dealing with challenges of information

To support the local police in fighting organized crime, it is important for EUPM to collect criminal intelligence from everywhere in Bosnia and Herzegovina and analyze it to create a good situational overview. The main sources of information for EUPM's headquarters are the local police, the daily reports from EUPM's field offices, and the security awareness working group. EUPM follows the general statistics of everyday crime in the country in order to notice crime trends that could be part of a bigger picture. Information that relates to police crime and police corruption is also important. The main source of such information is not the local police, but the local community. EUPM has informants who have high positions in society.

EUPM tries to obtain local information on the overall security situation together with EUFOR through EUFOR's Liaison Observation Team (LOT) house concept. These are

⁵Meeri-Maria Jaarva, Damir Durbić, and Willem Muhren

small groups of military people living in normal houses and liaising with the local population. Because people from LOTs are military peacekeepers, they are not always good at collecting criminal intelligence for EUPM.

The local police are an important source of information for EUPM, but EUPM often needs to “press out” information from them. This goes back to the time of the former Yugoslavia when having information implied having power and information would not be shared unless ordered. This culture of not sharing information with internationals was partially enforced during the IPTF time.

Traditionally, as effective tools were missing, the writing of many reports was the main means of analysis for the police after information was gathered, and these reports were stored in nationwide data systems. After the war there was no money to maintain these systems, and they were cut into smaller elements. Nowadays the police has to be aware of the fact that informants from different political parties and criminal groups could reside in their units. That is why the police do not document much anymore, but rather “store” important information in the heads of some trusted members of the police agency.

EUPM does not have a central database to retrieve important information from. All information is stored on local hard drives. There is a need for some kind of web-based application, but nobody thought of this when EUPM was deployed and now it is too late to implement something like this. EUPM does have an archive of aggregated reports that are sent on a weekly basis to the headquarters in Brussels, but these only indicate trends and not contain any detailed information, as they are intended for member states representatives and other people in Brussels who “are not interested in details, but that is exactly what we need here.”

EUPM has experienced difficulties in distributing its message to the citizens: “with normal press work you fail to communicate with the public”. The local media in the country are biased, and citizens tend to watch and read their own particular news and media. Whenever EUPM issues a press release it is reported in three different ways: from Serb, Croat and Bosnian angles. This means that it is not easy to reach out to the public. Bosnia and Herzegovina’s television networks are still underdeveloped and underfunded but constitute the most unbiased media in the country. However, the ratings are not substantially high. It is also difficult for EUPM to trust local journalists. This is why EUPM has set up their own relatively large media department, used to distribute their message to the citizens. EUPM launches their own television programs, does public information campaigns, organizes round-table discussions, and produces their own radio programs. An example of a newly set-up television program is the Bosnian version of “America’s most wanted”. This is a tool for EUPM to distribute police-related or EUPM-related topics. In addition, EUPM is producing a print supplement, called “Kronika 112” (112 is the Bosnian emergency phone number).

EUPM has introduced public complaint bureaus throughout the country, where citizens can report bribe demands or any other suspicious police activities. Once a year EUPM conducts comprehensive public opinion surveys in which they test the messages that have been sent out. EUPM also trains press officers of local police forces and police chiefs in media management.

In Bosnia and Herzegovina there is a system of liaison officers to communicate and share information between the different EU organizations. There is a liaison officer dedicated to EUPM in each EU organization. There are bi-weekly meetings to share security information between all the international organizations in the so called “security awareness working group”. That is one of the most relevant tools or systems to share information regarding the security and safety situation.

Some interviewees complained that few people understand that information sharing and coordination takes a considerable amount of time: “Sometimes you have some things which cannot be e-mailed, or which have to be encrypted. All these kind of things take time and have to be organized.”

Case study findings: dealing with challenges of frames of reference

In a complex country such as Bosnia and Herzegovina, EUPM needs information to be able to put police information and crime security information in the right context, interpret it in the right way, and identify the ways to proceed based on those interpretations. That is why EUPM collects a large amount of political information. And not only the local and national Bosnian political information is important, but so too is international political information such as that related to the situation in Kosovo.

The Bosnia and Herzegovina authorities carried out an organized crime overview and analysis, but this did not result in an accurate picture of the situation. There are many reliability problems regarding the information that is gathered and put together by the public administration because of different legislations, different practices and often an unwillingness to give out information. This is not necessarily because of corruption, but mostly caused by political preferences. The kind of information the political decision-makers are giving out depends on which view of the security situation they want to show. Every now and then there are some situations that are politically fueled and people are manipulated.

Other doubts were raised as to whether the international community in Bosnia and Herzegovina is basing its analysis on the right information. One interviewee was very critical of the international community, arguing that they do not conduct much field-based research. The failure of the international community to obtain information from local people in multi-ethnic areas has led to “a gap between the Bosnian reality and the way it is presented by the media and policy makers.”

There is a problem within EUPM concerning their institutional memory because of the high turnover of staff. EUPM does not have information sharing tools within the mission, causing internal information management to be based on daily, weekly, and monthly incident reports and the institutional memory to be situated in the heads of “veterans”.

Discussion of the findings

We observed two types of challenges concerning information (Table 2.1) in EUPM. First, to cope with *uncertainty*, EUPM engages in different information gathering activities. They

communicate with the local police, but as they do not have any system in place to store information and there are cultural differences in sharing information, it is difficult to obtain information from them. Moreover, EUPM is very active in media outreach to the citizens, for which they created a big media department, and has installed public complaint bureaus. Finally, EUPM has informants and liaising teams in place in the local community.

Second, it is difficult for EUPM to deal with *complexity* as their institutional memory is not sufficient. EUPM also lacks an IS with a repository function to compensate for this, which should store all information they receive. This not only leads to loss of details, but also to problems in interpreting what is going on in Bosnia and Herzegovina.

This leads to types of challenges concerning frames of reference (Table 2.1). First, EUPM tries to gather all kinds of contextual information, such as political information, to create a frame of reference and thereby to cope with *ambiguity*. But the question is how effective they can be at doing this, if there is no appropriate system in place.

Second, the doubts that were raised about whether the analysis of the situation is based on the right information, is a question concerning *equivocality*: there are several competing or contradictory frames of reference, and there is confusion on the appropriate frame to use in this situation.

In Section 2.3 we discuss the implications of how these actors deal with challenges of information and frames of reference for the design of crisis management IS.

2.2.5 Case study 4: The Democratic Republic of Congo's ongoing crisis

In the previous case studies we explored both the dealing with information and the dealing with frames of reference by crisis actors. In this case study we focus on humanitarian aid and development organizations that operate in the DRC, an African developing country that is facing an ongoing crisis since many years. Because we conducted more interviews, and had a chance to go more in-depth in the interviews and therefore gathered richer data, we choose to analyze the Sensemaking behavior of our respondents through Weick (1995)'s seven Sensemaking properties discussed in Section 1.2.1.

According to Hale (1997), a situation can be called a crisis when (a) there is a high consequence or threat to one or more central goals, (b) there is little available time in which to make and act upon decisions, and (c) there is a low probability of the event's occurrence. Organizations operating in developing countries share the first two traits with a "normal" crisis but not the low probability of occurrence. Clear and present danger seems to be ubiquitous. As a consequence, these organizations face circumstances that have no real beginning and no real end, envisage constraints and objectives tending to change continuously *en cours de route*, are characterized by changing staff composition, and are running the risk of fluctuating morale and motivation. Such circumstances are out of the ordinary and cannot be compared to normal crises. Therefore, from a research perspective, such crises offer an attractive field laboratory for observing and understanding

information processing and organizational decision making to the extreme. The DRC is a quintessential example of a developing country immersed in crises.

The DRC, since the 1990s, is in a permanent state of quasi-collapse (UN Development Group, 2007), with successive episodes of increasing violence by domestic and foreign armed forces. The result is 3.5 million people killed and many more displaced (UN Development Group, 2007) and a collapse of the country's formal economy, despite the abundance of raw materials. On the Human Development Index, the DRC ranks 168th out of 177 countries, making it one of the least developed countries in the world (UN Development Programme, 2007). In the last few years, considerable progress has been made to the stability in the country. Large-scale military activity ceased in early 2001, foreign forces formally withdrew in 2002, the UN peacekeeping mission Mission des Nations Unies en République Démocratique du Congo (MONUC) deployed more than 17,000 troops in the country, and political stability returned a bit when in July and October 2006 the first democratic elections were held since the colonial rule. Despite this marked progress towards recovery, humanitarian needs remain high (UN Office for the Coordination of Humanitarian Affairs, 2007). An estimated quarter of the population has critical food needs, and 71% of the people live on less than one dollar a day (UN Development Group, 2007). Pillages, arbitrary executions, sexual violence, torture, and recruitment of child soldiers make millions of people flee their homes, prohibit access to food and basic health care, and cause continuous threat of even more exploitation and assaults by the various armed groups (Médecins Sans Frontières, 2007). In such an ongoing crisis, humanitarian aid workers continuously face turbulence, even in the capital city of Kinshasa. Two particularly serious incidents in August 2006 and March 2007 turned Kinshasa into a war zone with regular army troops fighting opposition leader troops within the city and causing a genuine threat to their lives.

The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Humanitarian Action Plan 2007 (UN Office for the Coordination of Humanitarian Affairs, 2007) identified several constraints to the humanitarian response in the country. The endemic instability and insecurity in the DRC is one of the major constraints that hinder humanitarian access to the most vulnerable people. Besides this, the scale of the country and the poor infrastructure form a huge constraint to the humanitarian assistance. The DRC is vast, more than two-thirds the size of Western Europe but lacks reliable transport and communications infrastructure. According to the UN Development Programme (2007), there are even less than 600 km of paved roads in the whole of the DRC. They found that of the 10 provincial capitals, one can be accessed by land from the capital city of Kinshasa, three can be accessed from abroad, and six can be accessed by plane. The consequences are that there are huge difficulties and high costs involved in accessing parts of the population and that it complicates communication and the coordination between the head offices in Kinshasa and the field. The combination of the insecurity situation and the logistical problems pose humanitarian actors for nearly unbridgeable difficulties in accessing the affected population.

In the DRC, the common expectation is that bad things *will* happen. As Choo (2006) states, "changes in the environment continuously generate signals and cues. Unfortunately these messages are ambiguous and are compatible with multiple interpretations". This is

especially the case in ongoing crisis circumstances when there is no real end to their occurrence and their probability of actually happening is always high. Therefore, discontinuity is the rule and continuity the exception, and organizations working in developing countries need to deal with these circumstances appropriately. This has obvious implications for the way these organizations process information and make decisions.

Studying information processing and decision making in high-hazard contexts as in the DRC is highly relevant. First and foremost, the outcomes of such a study could lead aid and development organizations in the DRC to establish more effective and efficient communication and decision-making processes, which would ultimately benefit those people suffering from crises. Second, a better understanding of (inter-)organizational information and decision processes could leverage a further integration of these organizations towards cooperation extending beyond the mere exchange of information. In other words, information alignment could serve as a catalyst for organizational alignment.

Case study implementation

In August 2007, we⁶ traveled to Kinshasa, where we conducted 17 one-hour interviews with senior level key actors in the humanitarian aid and development sector. An overview of the interviews is provided in Appendix A.

We used the interpretive research approach as described in Section 2.2.1. Our main purpose was to let the interviewee tell his or her own story. On the basis of what was said, we followed up with further questions in that direction in a semistructured manner. The semistructured questions related to Weick (1995)'s seven Sensemaking properties so that we could better understand how interviewees made sense of their situation in this protracted crisis context. In particular, we tried to find out how actors reached a decision, whether they relied on previous experience, whether they relied on members of their team or other organizations, whether this decision was evaluated during the process, to what degree the information was accurate, what cues they focused on, etc. The interviews were conducted in English, though at times parts were in French, the official language of the DRC, which made the interviewees feel more relaxed. For each interview, permission for tape-recording was granted and confidentiality was guaranteed.

Case study findings on the seven Sensemaking properties

The interviews we conducted in the DRC confirm that at the base of information processing behavior in crises are the different Sensemaking properties by which organizations continuously are looking to add "sense and sensibility" to assess the situation. Using selected quotes obtained from these interviews, we illustrate in this subsection how the organizations' activities are permeated by the Sensemaking properties.

Social context To obtain the information they need, interviewees indicated that they will use and contact all sources within their reach.

⁶Gerd Van Den Eede and Willem Muhren

“You talk to different type of groups. You talk to the army, you talk to the civilian authorities, you talk to the local authorities, you talk to the population, the church, the NGOs . . . a number of parties.”

The interviewees indicated that it was very important for them to have a discussion with their colleagues within their organization.

“You do not know everything yourself.”

“Very often I meet with the staff members and discuss topics before decisions are made.”

“In such a big operation, it is important to work with a deputy. The fact that we work together is very important, amongst others to create new ideas, new thoughts, and new ways of looking at things.”

Furthermore, sharing information and discussing this with people from other organizations was also regarded as important.

“Being with many actors, it is very important to exchange the different views and analyze them. Very often you have a piece of information, the share of it, so you have to put it on the table and share it with other people. In that way, you can get some kind of a story.”

Identity construction The following quote is a good example of how the identity of the organization defines how this actor operates. The concept of maintaining a positive organizational image is in this respondent’s mind in everything he is doing.

(Talking about the importance of neutrality for his organization): “Maintaining the brand of our organization is important. Internally, but also outside.”

One of the respondents saw herself as competent, important, and efficient and clearly transmitted that message to us. Apparently, it is important to her, for her role within the organization and to the outside world, to have this high self-esteem and act accordingly.

“As any top manager, I handle from routine issues to big issues related to policy on any number of levels, from provincial to national.”

It was also realized by one interviewee that this has implications for the decisions that are being made.

“[Decisions that are made] are dependent on the people who make the decisions. If there were other people to make the same decision, the decision outcome very well might be different.”

Retrospection When facing situations, people often guide their decisions by looking back at previous experiences.

“Having seen the system work in Baghdad – or not work in Baghdad – I take things with a grain of salt. My tendency is to be more cautious after what happened. So I don’t take what security people tell us at face value, for instance.”

Collective or organizational experience is evidently important for the actors, as two other interviewees explain.

“Not only the common sense but also the experience we have – unfortunately from the past, because we had to proceed for evacuation several times here in Kinshasa – will tell you very rapidly whether we will proceed to an evacuation or not.”

“Our organization has been around for quite a while, and we have been evacuated on occasions in various countries. So it just becomes a matter of experience to know when to evacuate.”

An even stronger indication of retrospection can be found in the reference to the “collective knowledge of the humanitarian community.”

“The key is the quality of your collective knowledge: They are the history of that war and the patterns that are played out in that war. And then you know as we know in Eastern DRC, that historically this conflict, this war in Eastern DRC, has led to considerable forced population displacement. You see patterns changing a bit here and there but you do know already that what is going to happen is that you are going to have X-numbers of people being forcefully displaced. It has happened since 1994, 1996, 1998, and we can continue. That is what I call collective knowledge of the humanitarian community.”

Cue extraction The actors working in the DRC pay a lot of attention to cues from the complex environment in which they work. An important cue appears to be anything related to the security situation. One interviewee explained his continuous search for such cues.

“You can see a situation developing. We’re constantly monitoring the political and military situation, being alert to indicators we’ve established. And sometimes you just see things. Why did I see five trucks full of heavily armed soldiers going on my way home today?”

Cues from the environment function as triggers for decision making, as another interviewee explained.

“What triggered a number of decisions [during the March crisis] on my part is the fact that supermarkets and people were just closing down. When, in Kinshasa, shop owners and taxi drivers stop, then you know it’s serious!”

Determining which information is correct and which can be trusted proves to be a challenge.

“There’s so much talk here. There are so many rumors in this country flying, you know, at any point. It’s really difficult to know what you can trust, what information you can trust, and what information you cannot.”

Ongoing It should not come as a surprise when respondents report a broad information gathering activity as a basis for understanding what is going on.

“[Information that is important] it’s political, it’s the context, it’s everything. We use all information that we can get, and assess its applicability to whatever we’re doing.”

Different sources are consulted.

“On the operational level in the east, each agency has its own frequency and then there’s a shared channel, and there’s also a UN security channel. Our radio operators and guards sit there with three FM radio’s each in front of them the whole time so they can always hear if something is going on on the UN radio. They can always hear if something is coming through.”

Plausibility The DRC is without doubt a complex environment in which to operate. “There are so many things happening here and sometimes we cannot respond too fast,” as one interviewee stated. Due to the large size of the country and its poor infrastructure, it is difficult to obtain the accurate information that is needed.

“We don’t have the feeling that we get enough information from the field. In a big country like DRC, you cannot pretend to have all the information coming from the field.”

This unofficial information was often termed “radio trottoir,” which is the French term for “news from the street”. Our respondents heavily rely on this unofficial information.

“About 70% of my decisions are guided by officious information.”

“They [local people] are the best advisors, they are from the country. I don’t run blind; I cross-check information, but I indeed act according to their information.”

“[If the official and unofficial information is conflicting], we would give much more credits to the officious information, to the streets.”

All the different types of information coming in from different sources lead to information overload. People tend to rely on their own rules of thumb for dealing with this problem.

“There is information overload. What I do, I make a confession: If a document contains more than three pages I don’t read it. I never read anything that’s more than three pages. There’s a lot of information, and I know that I’m missing out a lot of information.”

Enactment It is evident from the interviews that, especially due to time constraints, actors do not have time to list all possible courses of action and evaluate them when decisions have to be made. Instead, they need to act upon the information they have and thereby shape their situation.

“Sometimes you have to base your decision on uncertain information because time is more important. In a crisis situation, you should react. You might react wrongly, but of course you should react in a way that doesn’t harm [talking about a crisis he faced]. So we shut the embassy to help the local people. If it wasn’t necessary, what do you lose? A few working hours; it doesn’t cost you very much, but if you wait it often becomes too late.”

Furthermore, one of the most characterizing observations was that for most of the interviewees, it is important to visualize the situation in the DRC on a map, reflect on it by consulting it from time to time, indicating specific operational areas or events, and highlighting important areas with a marker or inserting flags.

Discussion of the findings

These findings show that the DRC is a developing country suffering from an ongoing crisis that affects the daily routines of any organization operating in the country. These circumstances create a precarious environment in which organizations need to conduct their daily routines and be continuously on guard for any signs of imminent disruption or increasing threat. As argued before, Sensemaking theory is focused on answering the question, “what is going on?” (Weick, 1993). Knowing what is going on is an essential prerequisite for response as otherwise organizations may not know why or how to respond. The results presented above illustrate that Sensemaking is a critical, ongoing activity for the actors we interviewed. Moreover, it shows that actors in the DRC also cross their organizational boundaries to make sense of their situation by making use of the interorganizational network.

In Subsection 2.1.2 we argued that when operating in an environment of continuous threat and risk of a new acute emergency, organizations focus on information gathering from different sources, review and update where needed their organizational crisis memory, and

verify the scope and nature of the continuously changing crisis situation and the validity of information they have available through coordination mechanisms in their network. In the next section we compare our Sensemaking findings from this case and the more general information processing findings from the previously discussed cases to the premises underlying the design of crisis management IS.

2.3 Design of Crisis Management Information Systems

The first three case studies gave us insight into how actors cope with information processing challenges in various crisis situations, and the fourth case study gave us more understanding of how Sensemaking works in a crisis. But what can we learn from this for the design of IS for crisis management? To answer this question, we examine IS design guidelines for crisis management as developed for a DERMIS (Turoff et al., 2004) to support the response to crises, and compare these guidelines to our findings on dealing with information and frames of reference (case studies 1–3) and the presence of Sensemaking properties (case study 4). Because we focus on the information, information processing, decision making and Sensemaking aspects of crisis management, we use the seven out of the nine DERMIS design premises for this discussion which have been illustrated in Table 2.2. As mentioned in Subsection 2.1.2, we do not include the other two DERMIS design premises on roles and training in our analysis.

DERMIS' design premise 1, "information focus", clearly is about dealing with information, specifically on dealing with complexity. On the one hand, IS should enable users to obtain the full context of what is happening. On the other hand, IS should protect its users from information overload. In the Barents Rescue Exercise, some actors argued that they need detailed information, while others just wanted the most relevant information. The premise on information focus is about filtering out information so actors work with the level of information that is most suitable and/or preferable to them. The people working for EUPM experienced the problem that there is much information "out there", but that there are no systems in place to make use of that information and analyze it. Design premise 1 also focuses on the importance of creating a good picture of what is going on by giving actors access to all contextual information. This overview will aid in creating a suitable frame of reference, as we saw at EUPM where police information, criminal intelligence, and political information is collected from all around the country and is used as contextual information to construct good frames of reference for their operations. As we have seen in the DRC, humanitarian actors face the same trade-off between obtaining the full context and avoiding information overload. They try to obtain all possible information, but this has led them to a situation in which there was too much information to process and thereby possibly important information has not been taken into consideration. Therefore, they are continuously forced to act on plausible information. The DERMIS premise of information focus is reflected in the Sensemaking properties of ongoing and plausibility.

DERMIS' design premise 2, "crisis memory", only supports dealing with frames of reference: by having access to historical information on the situation, actors will have the foundation for establishing a suitable frame of reference. In the Barents Rescue Exercise, respondents have explicitly mentioned the importance of experience in crisis situations. EUPM actors also acknowledge that experience is important, but face problems of crisis memory due to high staff turnover. The ANPC in Portugal makes sure that the lessons learned from a crisis are incorporated into their procedures, in order to improve their response to following crises. The Sensemaking property of retrospection supports the argument to enable learning from prior experience, as was perhaps most strikingly expressed by an interviewee's observation in the DRC on the importance of the collective (crisis) memory of the humanitarian community.

DERMIS' design premise 3, "exceptions as norms", also only deals with managing frames of reference, as it stresses that almost everything in a crisis is out of the ordinary and cannot be planned for. Hence, it refers to the fact that there cannot be one frame of reference for a crisis situation. You cannot know in advance what will happen in a crisis and how it will evolve over time. Instead, flexible systems are needed that adapt to the changing conditions and that support changing frames of reference. Planning for a crisis is therefore difficult, and expectations of other actors – perhaps guided by previous experiences, agreements, or "common sense" as perceived by one side – are not always met, as Norwegian and Finnish actors experienced in the Barents Rescue Exercise. As indeed the exception is the norm in a permanent crisis as in the DRC, our results indicate that actors are mostly not able to foresee what will happen in such a rapidly changing environment, and they will continuously try to extract cues from the environment (the Sensemaking properties of cue extraction and ongoing) to make sense of their situation and are forced to act upon plausible information (the Sensemaking property of plausibility). IS could assist actors in this cue extraction with data mining and outlier detection (Song, 2005).

DERMIS' design premise 4, "scope and nature of crisis", states that the way of acting in a particular crisis depends on the type of situation. This design premise is overarching for our case studies, and is reflected by the different types of management of the crises we saw in the case studies and the taxonomy shown in Table 2.3. Crises differ in their nature and their scope, and to counteract this, the associated management of the crisis – either it is prevention, response or recovery – must be adapted to that situation. According to Sensemaking, actors are continuously relating their situation to what is happening through "ongoing" and "cue extraction." This is also related to the Sensemaking property of "identity construction": the Sensemaker is, in continuous interaction with the environment, seeking to discover what he or she thinks and knows about the crisis situation.

At first sight, DERMIS' design premise 5, "information validity and timeliness", only seems to be about supporting the coping with uncertainty, as it describes the "usual" situation that there is incomplete information. This point was made by the people in the OSOCC at the Barents Rescue Exercise, as they stressed the importance of continuous up-to-date information on the situation. In the Portuguese case study we have seen that the Forest Services were continuously gathering information on fire risks and were making it available to everybody by means of fire hazard maps. The importance of information

validity revealed itself in the observation of redundant information exchange behavior at the Community Mechanism for Civil Protection. However, design premise 5 is also about organizing all information available, enabling actors to construct the best possible frame of reference. In Portugal we have seen the example of the use of media to provide citizens with timely information that they should be careful with combustible materials and the use of fire, and the new concept that in winter fires can be good. In Bosnia and Herzegovina, actors have to be careful for manipulation of their frames of reference through other parties' partial or biased information sharing, mostly caused by political preferences. The Sensemaking properties of plausibility and cue extraction are directly related to our observations in the DRC that actors base their decisions on information that is available to them, information that is usually not up to date, inaccurate, incomplete, or incorrect. We observed that actors base their decisions on an inaccurate picture of what is happening and use unofficial information, such as "radio trottoir", in order to understand what is going on.

DERMIS' design premise 6, "free exchange of information", is also intended to support dealing with both information and frames of reference. Design premise 6 is about the importance of the social context that is used to gather and exchange information. In the Barents Rescue Exercise there was no free exchange of information between the important actors, such as between OSOCC and LEMA. In Portugal, the Forest Services experienced problems of acquiring up-to-date information for their fire hazard maps. Cultural differences, fear of political and criminal infiltration, and ethnic barriers made free exchange of information nearly impossible in the post-conflict setting of EUPM. But we also observed good examples of free exchange of information, such as CECIS which allows actors to share information on the crisis situation, and ANPC's use of the media to reach out swiftly to the citizens. The social context is also used to compare frames of reference. Free exchange of information for this purpose was hampered in the Barents Rescue Exercise by physical separation of key actors without sufficient IS support to overcome this, and the involvement of actors using different languages and having different cultures. In the Portuguese case study we saw interpretation problems arising from a lack of standardized language in CECIS. There was however an example of a good infrastructure for exchanging information in the Community Mechanism for Civil Protection, that led to better familiarity of the other countries' problems, resources, and capabilities. In the DRC we also observed the importance of having access to the relevant information sources and expertise in crisis situations. However, actors mostly do not know which source to consult or do not have access to it, due to physical limitations (e.g., lack of IT infrastructure), cultural, or security barriers. Evidently, and notable through the use of informal contacts, our results show that people use all information sources they have access to.

Finally, DERMIS' design premise 7, "coordination", directly relates to response activities when a crisis occurs and the responsibilities of various actors. During the preparedness phase of a permanent crisis, this premise can be understood as the wide array of arrangements and spontaneous actions, both formally and informally, that are made within and among organizations to make sense of the environment. This is best illustrated in our results through the presence and abundant use of the social context Sensemaking property.

2.4 Chapter Conclusions

In this chapter we have explored four common information processing challenges in different crisis situations. Although all information processing challenges were present in the case studies, some challenges were more common in specific situations. At the airplane crash in the Barents Rescue Exercise there were at first many uncertainty related information problems. As this was a sudden crisis, actors obviously did not know what was happening in the first stages of the crisis. In the EUPM in Bosnia and Herzegovina we observed that the main problem was dealing with complexity, as a lot of information is gathered but cannot be analyzed and processed adequately due to a lack of systems and procedures.

We observed that the common trend in these crisis situations was that actors at first focus on information related problems, especially uncertainty problems of acquiring information, and then shift to strategies of coping with the complexity of too much information. This is an interesting finding and needs to be validated in future research. IS traditionally play a significant role in these areas of information related problems, as they can support people in storing, retrieving, and analyzing huge amounts of data. This can be considered to be the realm of Decision Support Systems (DSS).

The dealing with challenges of ambiguity and equivocality was mentioned less often. For an ongoing crisis situation as the forest fires in Portugal, we saw the importance of providing citizens with frames of reference. By supporting them in their situations of ambiguity, more severe forest fires can be prevented as people learn how to handle and prevent them, and people do not start to panic immediately when they see a fire on television. Usually, however, the dealing with challenges of ambiguity and equivocality is not the specific aim of the actors, as they handle them more implicitly. For these challenges it is less important to search for more information. Rather, people try to manage their frames of reference for interpreting the information by activities of Sensemaking.

In Sensemaking, we found a theory enabling us to analyze and understand information processes of networked organizations operating in the DRC where information is often volatile, frugal, or unofficial and therefore difficult to assess and process for decision making. Here, Sensemaking gave us insight into the black box of information processing and allowed us to understand how actors go about with the characteristic gappiness of an ongoing crisis. In the interviews we conducted, all of the Sensemaking properties could be recognized, indicating that Sensemaking is deeply rooted within the real life experiences of international aid and development organizations operating in the DRC.

When we compared our findings to the DERMIS design premises, we found that all seven investigated premises in some way contribute to the support of the dealing with frames of reference, and have illustrated that all Sensemaking properties are reflected in the DERMIS premises for designing IS. If crisis management systems are designed to support access to all contextual information (design premise 1) and storage of historical information and incorporation of lessons learned (design premise 2), actors are supported to construct good frames of reference; if these systems are designed to be flexible during the response (design premise 3) and adaptable to the nature and scope of the crisis (design premise 4), actors are supported to update and change their frames of reference. Finally, as general

requirements, if systems facilitate interaction and collaboration by supporting timely and valid information exchange (design premise 5) without any impediments (design premise 6), enabling effective coordination (design premise 7), actors are supported to create, compare, update, and change their frames of reference.

Consequently, actors in crises could enhance the effectiveness and efficiency of their interactions on the condition that they could rely on IS that support the natural cognitive process flow rather than suppress it. For that reason, IS that are designed according to the premises outlined in this chapter would constitute a leverage for a stronger, more stable, and more genuine inter- and intra-organizational collaboration in the field of crisis response. We have argued that such is not unrealistic when network members experience the advantages of Sensemaking Support Systems (SSS) which enlarge their network, leave room for their identity construction without the straitjacket of blind accuracy and predefined decision making tracks, have the flexibility to diverge and converge on the fly, and test small hypotheses taking into account lessons learned (Van Den Eede et al., 2008b; Muhren et al., 2007).

The results of our exploratory case-based research provide arguments to counter Weick's original and then justified criticism on the lack of Sensemaking support in IS design, and at the same time demonstrate the continuous struggle for crisis actors to make sense in practice. We expect our findings to encourage IS researchers and practitioners to develop and implement IS to support the Sensemaking properties and at the same time the DERMIS design premises.

Chapter 3

Making Sense of Media Synchronicity in Humanitarian Crises*

Calamitas virtutis occasio est.

Seneca

The context of humanitarian crises is a particularly fertile soil for communication research. Processes are magnified because of their ultimate life-saving objective. Moreover, stringent time dimensions offer an interesting perspective because people are often forced to act immediately. For these reasons, the theoretical and practical relevance of studying communication in a humanitarian crisis context is high and has important consequences, particularly for the design of IS aimed at supporting it. Because humanitarian actors face Sensemaking and communication problems in times of crises and because communication and Sensemaking seem to be two interwoven processes, both should underlie the design of supporting IS in humanitarian environments.

Media Synchronicity Theory (MST) matches media capabilities to the relevant communication processes and can therefore be used to study communication performance (Dennis et al., 2008). In this chapter, we emphasize the Sensemaking processes underlying MST and apply these in the context of a humanitarian crisis. For this purpose, we have studied communication challenges from a Sensemaking point of view in the DRC (in accordance with research question 4) and show how media capabilities fit a Sensemaker's communication needs in the humanitarian environment of the DRC (in accordance with research question 5). The answers to the research questions are formulated in Chapter 6.

This chapter is outlined as follows. In Section 3.1 we discuss MST. In Section 3.2 we show how Sensemaking provides three important insights for MST, and propose an integration of both frameworks in Section 3.3. In Section 3.4 we describe the case study we conducted in the DRC. In Section 3.5 we describe our research methodology. We continue with the presentation of the data we gathered in Section 3.6, and discuss these data in

*This chapter is based to a great extent on Muhren, Van Den Eede, and Van de Walle (2009)

Section 3.7. Finally, in Section 3.8 we formulate conclusions and implications for theory and practice.

3.1 Media Synchronicity Theory

Literature on the use of media is characterized by many theories, two of which are Media Richness Theory (MRT) and MST. Below we discuss both of them.

MRT argues that organizations process information in order to manage uncertainty and equivocality effectively and that communication media should be selected according to the specific situation at hand (Daft and Lengel, 1986; Daft et al., 1987). Communication media vary in their capacity to process rich information, with information richness being “the ability of information to change understanding within a time interval” (Daft and Lengel, 1986). Two important conclusions of MRT are (1) that rich media (e.g., face-to-face communication) are better suited to reducing equivocality, and (2) that media of low richness (e.g., documents) are better suited to reducing uncertainty (Daft and Lengel, 1986). However, studies have not found unequivocal support for MRT when “newer” media (e.g., computer-mediated communication and video communication) were examined (Dennis and Kinney, 1998).

MST was initiated by Dennis and his colleagues to overcome the limitations of MRT (Dennis et al., 2008; Dennis and Valacich, 1999). MST is not a theory of media choice as MRT is, but rather focuses on communication performance, particularly on the ability of media to support synchronicity for an improved communication performance. Media synchronicity is defined in MST as “the extent to which the capabilities of a communication medium enable individuals to achieve synchronicity,” with synchronicity being “a state in which individuals are working together at the same time with a common focus” (Dennis et al., 2008).

In MST, communication is used as a synonym for the development of shared understanding in the context of a specific task. MST suggests that supporting media should fit two fundamental communication processes: (1) *conveyance processes* leading to individual understanding and (2) *convergence processes* leading to shared understanding. Communication media should not only support the transmission of information, but also the manifestation of meaning (Sutcliffe, 2001; Sitkin et al., 1992). Dennis et al. (2008) introduce in MST two subprocesses necessary for the conveyance and convergence communication process: (1) information transmission and (2) information processing. The communication process shown in Figure 3.1 is based on Shannon and Weaver (1949)’s classical theory of communication. The process starts with the source, the sender of a message, who uses a transmitter to encode the message into a signal. The message is sent over a communication channel (medium) to a receiver, which is used by the recipient (destination) to decode the signal back to the original message.

Moreover, Dennis et al. (2008) introduce five media capabilities that influence information processing and transmission: information transmission is influenced by transmission velocity, parallelism, and symbol sets, while information processing is influenced by re-

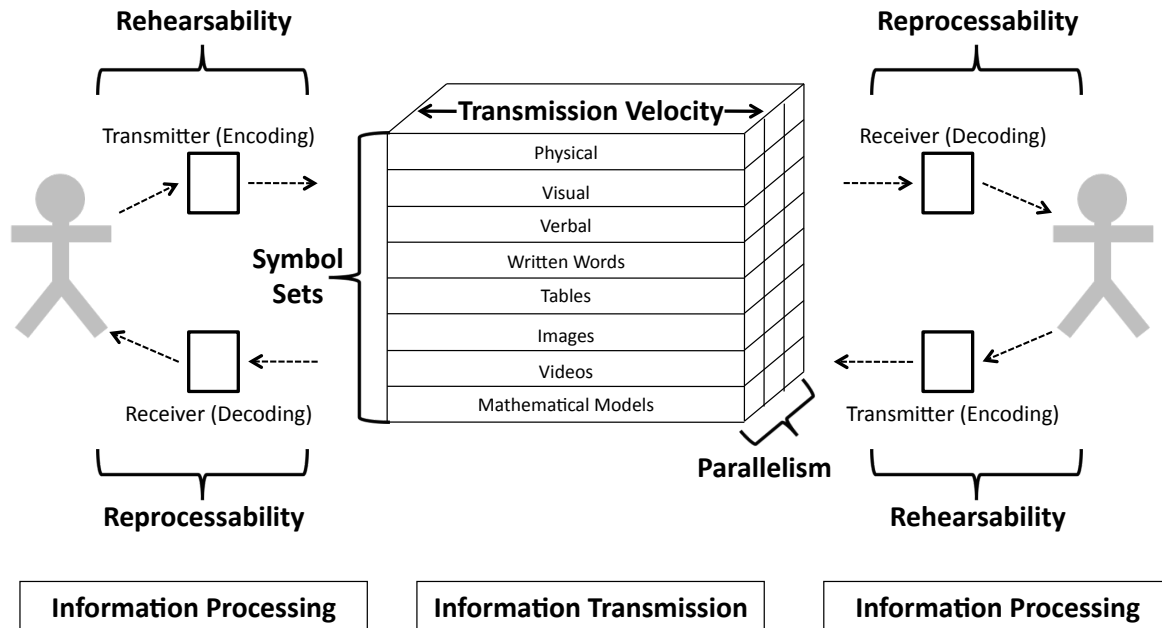


Figure 3.1: Communication process and media capabilities, adapted from Dennis et al. (2008)

hearsability and reprocessability.

First, the media capability of *transmission velocity* refers to “the speed at which a medium can deliver a message to intended recipients” (Dennis et al., 2008). Media supporting a high degree of transmission velocity can approach continuous exchange between people.

The second media capability is *parallelism*: the number of simultaneous transmissions, from multiple senders, that can effectively take place. This influences the quantity of information that can be transmitted in a certain time period. The advantage of high parallelism is that messages can be transmitted and received simultaneously, without having to wait until the channel is clear or open (Weick, 1990). However, high parallelism can also lead to information overload, since messages pile up for the recipient to process.

Third, the media capability of *symbol sets* refers to “the number of ways in which a medium allows information to be encoded for communication” (Dennis et al., 2008). Media can allow for natural symbol sets, such as physical gestures, visual signs, or verbal communication, and less-natural symbol sets, such as written or typed communication. Although symbol sets also influence the ease with which information can be processed, they mainly impact the transmission of information (Dennis et al., 2008).

Fourth, *rehearsability* is defined as “the extent to which the media enables the sender to rehearse or fine tune a message before sending” (Dennis et al., 2008). By using media with a high degree of rehearsability, the sender has time to think of how the message can best be understood by the recipient. This can also be a disadvantage, since carefully rehearsing

the message creates a delay before the transmission is even started.

Finally, when the message has been transmitted, the media capability of *reprocessability* plays an important role, “the extent to which the medium enables a message to be reexamined or processed again” (Dennis et al., 2008). With a high degree of reprocessability, the recipient has the ability to consult the content of the message either during the communication process or at a later stage. Therefore, this could lead to delays in decoding the signal and, consequently, delays in the following transmission of information.

These five media capabilities influence synchronicity for conveyance and convergence processes (Dennis et al., 2008). As indicated in Table 3.1, transmission velocity and symbol sets have a positive impact on a medium’s capability to support synchronicity, while parallelism, rehearsability, and reprocessability have a negative impact on a medium’s capability to support synchronicity. MST suggests that for improved performance of conveyance processes, people need low synchronicity media because “conveyance focuses on the transmission of large amounts of raw information and subsequent retrospective analysis, suggesting that an individual will have less of a need to transmit and process information at the same time” (Dennis et al., 2008). In addition, “to transmit information and enable analysis typical of conveyance, individuals do not need to work together or at the same time” (Dennis et al., 2008). Conveyance processes require more time for individuals to deliberate and to come up with their interpretations (Robert and Dennis, 2005). Conversely, Dennis et al. (2008) argue that “using media with higher synchronicity for conveyance processes (which require deliberation) may impair development of understanding because individuals will not have the time required to fully process the information” and that this will “encourage premature action”. People will therefore only need high synchronicity media for improved performance of convergence processes, since “individuals will have a greater need to quickly transmit and process smaller volumes of information to develop a shared understanding” (Dennis et al., 2008).

Table 3.1: MST’s media capability characteristics for low and high synchronicity

	Transmission Velocity	Paral- lelism	Symbol Sets	Rehear- sability	Reprocess- ability	Examples
Low Synchronicity Media	Low- Medium	Medium- High	Few- Medium	Medium- High	Medium- High	Voice mail, documents, fax
High Synchronicity Media	Medium- High	Low- Medium	Medium- Many	Low- Medium	Low- Medium	Face-to-face, video conference

3.2 MST and Sensemaking

In their initial development of MST, Dennis and Valacich (1999) incorporate earlier work by Weick (1985) and Weick and Meader (1993) on Sensemaking. However, in their most

recent and most extensive work on MST, they only mention this work circuitously (Dennis et al., 2008). No reference is made to the more mature work on Sensemaking that has been developed after 1993, as summarized before. However, the more recent work on Sensemaking provides three new and important insights for MST.

A first insight of Sensemaking, as we have discussed in Subsection 1.2.2, is that communication is not necessarily undertaken to reach shared understanding. Shared understanding can be the objective of Sensemaking by teams (Miranda and Saunders, 2003; Crowston et al., 2007; Nosek and McNeese, 1997; Kock and Nosek, 2005); however, this is not necessarily the objective of Sensemaking by individuals who make sense on the level of intersubjectivity and undertake social endeavors to negotiate their individual point of view, try to obtain new personal insights, and review their previous personal understanding.

Second, Sensemaking requires a broader view on the communication process than Shannon and Weaver (1949)'s classical scheme of the communication process, which starts with a sender and ends at a recipient. Sensemaking begins when people face an equivocal situation and have no idea of what is happening. As people struggle to make sense, they will not know who they should turn to or who will give them an answer to their questions. Sensemaking starts by defining who the sender is and who the recipient is.

Third, MST suggests that conveyance is a process that is performed from a certain beginning to an end with individual understanding as the outcome. It also suggests that people need low synchronicity media to be relatively undisturbed when reaching their understanding. An interruption of the conveyance process by enactment is considered to be "premature" (Dennis et al., 2008). Recent work on Sensemaking – as exemplified by the Sensemaking properties discussed in Subsection 1.2.1 – indicates, however, that conveyance is ongoing, with neither a beginning nor an end, and that "premature" acting is a necessary weapon on a person's quest for understanding. Conveyance, therefore, does not take a fixed amount of time but is ongoing in nature and characterized by social interaction and enactment. Low synchronicity media may not provide for the best support in this case.

This research addresses these newly obtained Sensemaking insights for MST. In the remainder of this chapter, we study communication when the objective is individual understanding rather than shared understanding. Hence, we focus on the conveyance processes. We provide an integrative view of the communication process through the Sensemaking processes that underlie MST. We describe the case study in the DRC, touched upon in the previous chapter but more extensively discussed and analyzed in this chapter. Here, we analyze communication from this Sensemaking perspective, and we show that low synchronicity media will not provide for the best support when striving for individual understanding through conveyance.

3.3 Towards an Integration of Sensemaking and MST

Our objective here is to detail and document the conveyance process of MST by placing Sensemaking – particularly the Sensemaking properties – in a communication perspective

and integrating it with MST. As shown in Figure 3.2, we organize the seven Sensemaking properties into four communication activities of (1) noticing, (2) interacting, (3) enacting, and (4) interpreting.

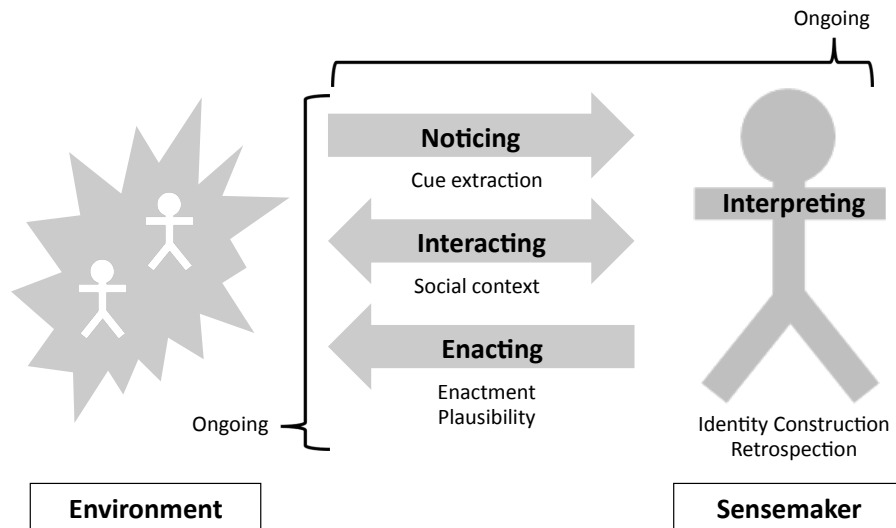


Figure 3.2: Sensemaking communication activities and their main underlying Sensemaking properties

Noticing is characterized by the Sensemaking property of cue extraction. How do people sense what is “out there”? People cannot pay attention to everything that is going on in the environment. Instead, they focus on specific cues. Noticing is “an awareness of environmental stimuli,” and communication plays an important role in it (Sutcliffe, 2001). The process of noticing stimuli can be both through formal and informal communication channels and either voluntarily or involuntarily performed by the Sensemaker. Environmental stimuli can be noticed through the Sensemaker’s own efforts and observations, or through other people in the organization who acquire information about the environment and communicate it to him or her (Sutcliffe, 2001). The Sensemaker can also notice or observe other people’s communicative events to refine his or her own mental model of the situation. Since the Sensemaker is mostly only on the recipient side of the information exchange, the role of communication is more passive in this case.

Interacting, and the inherent communication between interacting people, corresponds to the social dimension of Sensemaking, as it is through talk, discourse, and conversation that a large part of social contact is mediated (Weick, 1995). Individual perceptions and interpretations are influenced significantly by social information processes (Sutcliffe, 2001). In order to reduce equivocality, people engage in communication to understand what other people think: “The basic mode of Sensemaking is discourse, for it is through talk that organizational members find out what others think, and it is through talk that people persuade and negotiate their points of view” (Choo, 2006, p.77).

The third communication activity is *enacting*, characterized by the Sensemaking properties of enactment and plausibility. As Weick et al. (2005) write, “if the first question of Sensemaking is ‘what’s going on here?’ the second, equally important question is ‘what do I do next?’ This second question is directly about action”. People enact the environments that constrain them (Weick, 1988): “The pursuit of action generates new information and increases the opportunities for communication that helps executives modify erroneous understandings and allows them to update previously held inaccurate perceptions” (Sutcliffe, 2001). Moreover, enactment also enables people to understand better their cognitive processes: “People in organizations are continually engaged in talk in order to find out what they are thinking and to construct interpretations of what they are doing” (Choo, 2006, p.83).

With the activity of *interpreting*, characterized by the Sensemaking properties of identity construction and retrospection, we refer to the process of making sense of what is noticed, socially constructed, and enacted upon: “Communication is critical to the construction of information filters through which information is interpreted” (Sutcliffe, 2001). The resulting interpretation will heavily depend on who the Sensemaker is and who he or she strives to be, while keeping in mind the goals and image of the organization. Previous experiences of the Sensemaker and the institutional memory of the organization – an important component of crisis management – will play an important role as well and can take the form of stories and narratives (Weick, 1988).

Since Sensemaking is inherently an ongoing process, we do not attribute the remaining Sensemaking “ongoing” property to any specific communication activity. As such, we accentuate that the communication activities of noticing, interacting, and enacting do not form a linear sequence, but rather are intertwined with each other. Similarly, interpreting is not a separate activity, but Sensemakers are continuously interpreting while they are noticing, interacting, and enacting.

The Sensemaking communication activities of noticing, interacting, and enacting require the transmission of information. Information transmission is, as we know from MST, supported by the media capabilities of transmission velocity, parallelism, and symbol sets. Consequently, these media capabilities should also support the Sensemaking communication activities of noticing, interacting, and enacting. Similarly, we assert that the interpreting Sensemaking communication activity should be supported by the rehearsability and reprocessability media capabilities, as shown in Figure 3.3. This integrated model will be analyzed through a case study in the DRC.

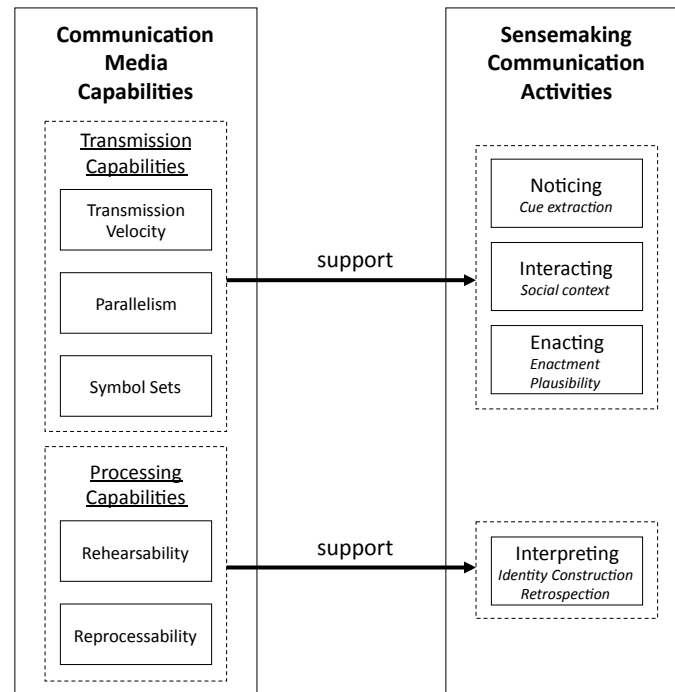


Figure 3.3: Integrated model of MST and Sensemaking

3.4 Case Study in the Democratic Republic of Congo¹

Humanitarian environments are characterized by ongoing crises, causing a continuous stream of cosmology episodes of which organizations need to make sense (Muhren et al., 2008b). Therefore, the relevance of studying how their information and communication processes can be improved is high (Bartell et al., 2006; Maiers et al., 2005). We have conducted a case study in the DRC to investigate how top managers of humanitarian organizations make sense of their situation and how they can be supported in doing this.

The DRC has a political history of colonization and dictatorship, and has frequently been torn apart through wars with neighboring countries and internal wars between the different ethnic communities. Despite being a naturally rich country, with minerals such as gold, diamond, and copper, the country's formal economy has virtually collapsed in the last few decades, from a GDP per capita of US\$ 380 (in constant dollars) in 1960, US\$ 224 in 1990, to just US\$ 139 in 2006, leaving only nine countries in the world behind on the measurement of human development (UN Development Programme, 2007; World Bank, 2007). Furthermore, especially in the east of the country, people are suffering from conflict.

In 2000, the UN Security Council decided to deploy a peacekeeping mission, MONUC,

¹We provided a basic description of this same case in Chapter 2; Here we provide additional background information, a more in-depth discussion of the research methodology, and a different analysis of the findings.

to the DRC. There were good hopes that the armed conflict would be halted after the involvement of the UN, the democratic elections in July and October 2006 (President Joseph Kabila winning by a small margin over his main challenger Jean-Pierre Bemba), and the subsequent disarmament process, but fighting between militia groups and the Armed Forces of the DRC continued.

There are many organizations deployed in the DRC to address the humanitarian needs of the population. However, the sheer size of the country and its poor infrastructure increase the difficulty for humanitarian organizations to provide the necessary assistance to people who need it. Moreover, humanitarian actors continuously face crisis situations in their work, even in the capital city of Kinshasa. Two incidents characterize this turbulent and dynamic environment: one incident after the elections in August 2006 and a second incident in March 2007.

On August 20, 2006, the day the preliminary results of the first democratic elections after DRC's colonial period were announced, Jean-Pierre Bemba was on his way to his television station to deliver a statement when troops loyal to Joseph Kabila started fighting with Bemba's troops. Both parties started using heavy weapons against each other in the center of Kinshasa. The next day the fighting continued, with members of Kabila's presidential guard attacking Bemba's home while he was meeting ambassadors.

On March 22, 2007, violence erupted in Kinshasa again between Bemba's personal guards and the national army when Bemba rejected Kabila's ultimatum to integrate his guards into the national army. Bemba's Movement for the Liberation of Congo did not want to agree to this demand since its members believed that their leader was in danger and would need protection. Bemba thereafter took refuge in the South African embassy in Kinshasa.

3.5 Research Methodology

Weick et al. (2005) state that "methodologically, it is hard to find people in the act of coping with disconfirmations that catch them unawares". Therefore, in order to understand how people make sense in a crisis and how they can be supported by IS, the case study was conducted from an interpretive perspective, drawing on the philosophical stance of hermeneutics (Berger and Luckmann, 1966; Klein and Myers, 1999; Mingers, 1984; Stake, 2005).

Interpretive research has the potential to produce deep insights into IS phenomena as it is "aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context" (Walsham, 1993, pp.4-5). Interpretive research attempts to accomplish this by understanding phenomena through the meanings that people assign to them, thereby assuming that our knowledge of reality is gained only through social constructions (Klein and Myers, 1999; Orlikowski and Baroudi, 1991). Interpretive research has a nondeterministic perspective, intending to increase understanding of phenomena within a specific cultural and contextual setting (Walsham, 1995a).

It is not possible to obtain value-free data in interpretive research because data are socially constructed: “The inquirer uses his or her preconceptions in order to guide the process of inquiry, and furthermore the researcher interacts with the human subjects of the inquiry, changing the perceptions of both parties” (Walsham, 1995a). Therefore, researchers should be wary of two commonly occurring shortcomings in interpretive field research in IS: (1) insufficient attention to critical reflection on how the research materials were socially constructed through interaction between the researchers and the participants in the field studies and (2) unwarranted theoretical bias in researchers’ interpretations of the field data (Schultze et al., 2000; Walsham, 1995b).

In order to minimize these shortcomings, our approach is based on Walsham (1993, 1995a,b, 2006)’s work on interpretivism in IS research and Klein and Myers (1999)’s principles for interpretive case study research in IS.

The following subsections provide a detailed description of how field data were collected (Subsection 3.5.1) and analyzed (Subsection 3.5.2).

3.5.1 Data collection

In August 2007, we² traveled to the capital city of the DRC, Kinshasa, where we conducted 17 interviews with top managers working at the DRC’s national head office of their respective organizations. We conducted interviews at the UN organizations, governmental organizations, and nongovernmental humanitarian organizations listed in Table 3.2. Although the ICRC is essentially nongovernmental, its administration does not want it to be called a Non Governmental Organization (NGO) due to its unique role granted in the Geneva Conventions. Thus, the second group of organizations in Table 3.2 is labeled “humanitarian organizations” and not merely “NGOs”. All of these organizations work in the DRC to improve the country’s humanitarian situation.

Throughout the preparation for the case study and the time spent in the DRC in between the interviews, data and understanding of the situation were supplemented by other types of field data, such as reports published by humanitarian organizations and the UN, background stories on websites, press articles on the humanitarian situation in the DRC, and informal interaction with local Congolese people.

All interviews were conducted in a familiar surrounding for the respondents: either in their office or in a general meeting room of their respective organization. To get the respondents to relax and to increase the quality of the interview (for example, in terms of honesty of response), we initiated each interview by reassuring the respondent about the purpose of the research and the confidentiality of the interview (Walsham, 2006). In the first few minutes, we introduced each other and explained the purpose of our visit. Then, often, the respondents inquired about our experiences so far in the DRC, the people whom we met thus far, and our plans for cultural activities before leaving the country. This short informal talk broke the ice and seemed to make the respondents feel at ease. We asked for

²Gerd Van Den Eede and Willem Muhren

Table 3.2: Overview of organizations in the DRC of which we interviewed senior staff

Organization type	Organization
UN organizations	Office for the Coordination of Humanitarian Affairs (OCHA) Mission of the UN in the DRC (MONUC) UN Development Programme (UNDP) World Food Programme (WFP) World Health Organization (WHO) UN Children's Fund (UNICEF) UN Population Fund (UNFPA)
NGO/humanitarian organizations	Association pour la Santé Familiale (ASF) Médecins Sans Frontières (MSF) Belgium Save the Children Oxfam GB Catholic Relief Services (CRS) International Committee of the Red Cross (ICRC)
Governmental organizations	Swedish International Development Cooperation Agency (SIDA) European Commission Humanitarian Aid Office (ECHO) UK Department for International Development (DFID) Belgian Embassy

permission to tape-record the interview and guaranteed participants confidentiality before the “real” interview began, and participants granted permission without exception.

In the remainder of the interview, which took on average one hour, we applied a semistructured interview technique consisting of questions related to Weick's seven Sense-making properties as the primary evidence-generation mechanism (Weick, 1995). The main recurring theme in the interviews was the respondents' experiences with cosmology episodes encountered in their work in the DRC, since it was at these occasions that people could have a sudden loss of meaning and that Sensemaking processes could be most obvious. The August 2006 and March 2007 incidents were brought up frequently by our respondents. In the interviews, the focus was mostly on situation-related matters indicating what the respondents needed and how they acted in a crisis situation, with less emphasis on work-specific matters, such as which humanitarian projects they conducted in the country and how they found out where the humanitarian problems were.

We conducted the interviews in a provocative style, using statements, metaphors, and dilemmas, and mainly letting the respondents do the talking about how they made sense of their environment. We adjusted questions according to respondent personality, world view, experience, and language, allowing the respondents to talk from their own phenomenological world (cf. Walker, 2006). We conducted most of the interviews in English. Because

one of the interviewers³ is fluent in French, the official language of the DRC, we had the flexibility to switch to some of the respondents' native language, which proved to be useful to clarify some questions when necessary and to make the respondents feel more comfortable. The respondents were actively stimulated to give examples and anecdotes and to call upon their memory. Credibility, which refers to the "truth, value, or believability of the findings that have been established," (Leininger, 1994, p.105) was ensured throughout the interviews by summarizing and restating key elements of what the respondents said.

We interacted in turns with each respondent. While one of us was in dialog with the respondent, the other would be able to concentrate on the big picture and think of how to proceed with the interview. In addition to the tape-recording of the interview, we took notes on the important points of what was said. Because we conducted the interviews in pairs, we were able to follow Walsham's recommendation to undertake a critique of each others style and sensitivity when deemed necessary after an interview. This method helped shape the interview approach into a "non-judgmental form of listening" (Walsham, 1995b). Realizing that the humanitarian top managers freed up their valuable time for these interviews, we also followed Walsham's advice about being sensitive to time pressures when fixing a suitable interview time and being especially flexible to finishing early when feeling that respondents were pressured by time, rather than irritate them by taking too much of their time (cf. Walsham, 2006). This approach resulted in a rich collection of experiences, providing for an in-depth analysis of the information and communication needs of the actors in the DRC.

3.5.2 Data analysis

The analysis of the data consisted of two steps. The first step was to transcribe all relevant parts of the interviews, in which "relevant" is defined as any sequence in the interview in which the respondents were describing crisis situations, their use and needs of IS, and how they make sense of their situation in general and in crisis situations specifically. As the questions in the interviews were structured around Sensemaking, the field data revealed many examples of how the respondents make sense in their humanitarian response activities, specifically, when they face a crisis situation.

As our goal was to study the role of communication when making sense of a crisis, the second step in the analysis phase was to extract all quotations from the transcripts referring to communication behavior, communication needs, and communication support in crisis situations. These data were analyzed according to the predefined Sensemaking communication activities. In order to prevent one of the main pitfalls in interpretive research, seeing only what the theory suggests, we attempted to "preserve a considerable degree of openness to the field data, and a willingness to modify initial assumptions and theories" (Walsham, 1995b). Hence, all the quotations related to a specific communication activity were grouped together, and new labels were created for groups that did not fit into one of these types. In case a quotation referred to more than one type of communication

³Gerd Van Den Eede

activity, it was added to the group to which it was considered to be the best fit. The quotations discussed in this chapter were selected based on their representativeness of the interviews conducted as well as the richness of the experience they describe.

Since we digitally recorded and transcribed the interviews and because we complemented the interviews with notes, information about the respondents, and pictures of the interview locations, the ability to confirm evidence from primary information sources (i.e., confirmability) was ensured (Leininger, 1994).

3.6 Empirical Data

In the data-analysis process, we identified groups of quotations that refer to the Sensemaking communication activities of noticing, interacting, and enacting. Within the activity of interacting, we defined five specific subcategories. As the activity of interpreting cannot be shown explicitly, no specific quotations could be selected for this activity, yet they are implicitly present in the other communication activities.

While for confidentiality purposes we reveal here no information that could potentially identify the source of the quotation, we indicate whether the source of each quotation is a respondent from a governmental organization [GOV], a UN organization [UN], or a nongovernmental humanitarian organization [HUM], as previously categorized in Table 3.2.

In Subsection 3.6.1 we present quotations that refer to the Sensemaking communication activity of noticing. In Subsection 3.6.2 we present quotations that refer to the Sensemaking communication activity of interacting, grouped according to five newly defined subcategories. Finally, in Subsection 3.6.3 we present quotations that refer to the Sensemaking communication activity of enacting.

3.6.1 Noticing

The respondents use many different information sources when sensing the environment. The most obvious sources are their interorganizational contacts.

“There’s a security tree among the international NGOs.... In terms of the information gathering, basically everybody does what they can on their side, and then they pass it on through the security tree.... Whichever point you get the information in, you pass it on to the one before and the one behind, and if one of those doesn’t reply, you go one down.” [HUM]

“There’s a lot of talking, there are meetings...and going to these meetings weekly there’s information that is passed, phone calls, text messages.... You get the general feeling that the message passes.” [HUM]

“Since we are in DRC from 1984, we have well-established contacts with the Congolese Secret Service [for information provision].” [HUM]

Besides the more formal interorganizational sources, personal contacts also play an important role.

“Words from our friends at the UN were important to know what was going on [in the crisis].” [HUM]

“We have friends with the embassies. . . . They give you as much information as they can. . . and it works now. . . . They have contacts within the city, to have kind of a what’s going on.” [HUM]

“Here I am far, but when you are in Goma or Bukavu, you know everybody. Everybody goes to the same pub in the evening. Everybody meets in the same meeting room twice a week. And of course, when there is an incident, information is spread quite quickly.” [GOV]

The respondents explained that the news of the street, “radio trottoir” as it is called in French, plays an important role in getting to know what is going on.

“Radio trottoir, what they call it, is really, really efficient here. It is not always true, but sometimes it’s incredible.” [GOV]

“I [unlike a Congolese] don’t know what the people say in the city, what they think, what the atmosphere is.” [HUM]

“[At the time of the crisis] local people would start hearing things on the street. And some of our staff had been out and started to hear something as well.” [HUM]

Local staff members can help international humanitarian actors to understand what is going on in the country.

“We were warned about the uprising, not only through our different contacts with different organizations, different NGOs, different UN, but from our local staff as well: what they were saying, what the mood is.” [HUM]

“For us it’s easier than for the people in the headquarters in MONUC, because we have a lot of national staff. . . . We get information from them and their networks here. Whereas in MONUC there are hardly any Congolese people; most people work in a vacuum. That’s a common complaint of MONUC staff. . . . Connections with local people is essential, otherwise you’re in a vacuum.” [UN]

Respondents indicated that they try to diversify their sources and try to have a network of people and organizations that can provide them with information in specific circumstances.

“The sources I have, I rely on them for specific information. For political information there are weekly meetings. OCHA is another source of information for things. And then I have also national staff and friends. So everyone would

give you their version. So if you're lucky you might get all this information." [HUM]

"The fact that my husband works in MONUC, I have access to an incredible amount of information that I would not otherwise be privileged to. And I pass it around." [UN]

"Our military attaché with his information network was the first one from the embassy to be informed, and I believe he was informed quite on the spot, by a telephone call at night at his home." [GOV]

If the organization does not have a good network in place, they could obtain important information too late or might be left completely in the dark.

"Here in the DRC we have an intelligence system that works for some and doesn't work for others. For example during the crisis in March, the embassies and private enterprises etcetera, they were receiving reports that something was imminent, something was going to happen, from early in the day. I have quite a few examples of people who were advised to take their kids out of school, etcetera. But nothing was done for the UN. The UN did nothing, nothing. So, in essence, we were caught with our pants down. And people were blocked. There were 300 people blocked here in this building, and stayed here for two days. And without having access to any information, you know. They could not figure out what was going on." [UN]

But having so many sources of information can pose problems for people to make sense, since they will have to keep track of all these parallel channels.

"On the operational level in the East each agency has its own frequency and then there's a shared channel and there's also a UN security channel. So our radio operators and guards sit there with three FM radios each in front of them the whole time, so they can always hear if something is going on the UN radio. They can always hear if something is coming through." [HUM]

3.6.2 Interacting

Analysis revealed that our respondents engage in five specific types of interacting. First, our respondents interact to *update* their understanding of the situation; they actively consult their network and maintain their contacts to stay informed. The second reason for interaction is to *inquire* about specific things they want to know. Third, our respondents engage in contact with other people to *triangulate* information and negotiate on what is going on. Fourth, actors interact to *verify* information. Fifth, our respondents indicated that they interact to *reflect* with colleagues on what to do and the decisions they need to make.

Updating

It is important to have regular contact with other people and organizations.

“To get a good coherence of what is happening, the starting point is to share assessments of humanitarian needs and the security environment. Being with many actors, it is very important to exchange the different views and analyze them.” [HUM]

“We interact with others in all cases, in all cases.” [UN]

Our respondents indicated that they keep in touch with many different contacts to stay informed.

“We talk to different types of groups: We talk to the army, to the civilian authorities, to the local authorities, to the population, the church, the NGOs, a number of parties.” [UN]

Many of these contacts are interorganizationally established.

“There is a platform for the donor community that is meeting regularly.” [GOV]

“There are NGO collaboration mechanisms. There is an inter-NGO network. Back in March there were some security problems, and at that time a lot of messages were being passed [through this network]... So there are different mechanisms in place to get information around. This one is strictly NGO-based, but there are others that are more government related. And the UN is very good about sharing-especially security-information, and other types of information relating to the host government issues affecting NGOs. So it’s a matter of networking, really. But it is ad hoc in many ways.” [HUM]

Personal contact with people is highly valued.

“Teleconferences, I hate them ... It’s the most horrible way to communicate ... because you can’t see other people’s faces. It’s little stuff but ... you’re not physically present.” [HUM]

“We have set up special websites, for the humanitarian clusters, where people are supposed to post information...but they’re very rarely used. I don’t use them myself. I prefer to directly receive documents. I think people need to have this personalized contact.” [UN]

People do not only use interorganizational contacts to stay informed. Personal-based contacts are very important.

“We get [security-related] information from our security company. That’s one route. We also have our head of security, who tries to be connected to the local scene.” [HUM]

“Part of that [contact with other NGOs in crises] is just networking, knowing what other people are doing: ‘What are you guys doing?’ And so a lot is through those types of contacts.” [HUM]

“The UN has regular reports which we cannot always get access to, so we usually just rely on our friends that work there, so just kind of right through. The new country representative, her husband works for UNHCR, so he would have access and would be able to send it much more . . . I mean, we would have much more of a direct link.” [HUM]

“I exchange information with colleagues at other embassies, I would say informally. But there are also always different types of formal infrastructures.” [GOV]

Therefore, people build up and maintain their own network of contacts.

“If you have bad relationships with your colleagues on the field, you will miss a lot of information. Sometimes in a crisis situation it goes fast, so if you don’t have a good personal relationship with people it will make your work difficult. [They will not tell you the information they have.] So from time to time, take one beer, chat with the other partners. It’s very good and helps a lot.” [UN]

“We have meetings between the security officers of the EU embassies . . . due to the incidents we had here over the last three years, during the whole election process and the recent violent clashes between Kabila and Bemba. We – several people from the embassies – happened to learn to work together.” [GOV]

Inquiring

In a crisis, people are in need and search for various kinds of information.

“If there would be a crisis situation, we would be looking for key information to make sure that our program and our people are safe: where are our people, where are they going, where is their danger, and how does, whatever situation, compromise or affect our movements and our activities.” [HUM]

They contact people from their network if they want to know something specific or are in need of their expertise or knowledge.

“The different staff here, we have different networks. Practically what has happened: We see the troops are moving so we try to find out what is happening [by contacting the various contacts].” [GOV]

“I confer or consult people who have good information of what’s going on out there.” [UN]

“There are a number of national staff members who have good connections that I would contact in a crisis situation. And we know socially people who are not with the UN system, they’re with private industry, who seem to be more aware of. . . I don’t know, things that are happening, that I would also contact now. This is from the March incident. These are a few like lessons learned from what was happening in March. Because they knew much earlier what was going to happen, and they were able to take proactive action.” [UN]

These inquiries are done on a personal basis. Personal inquiries help actors obtain their required information in a short amount of time.

“Informal messages go quickly. If I need to have an advice or opinion from the Ministry, I have to write officially. But I can also contact the secretary of the ‘Directeur de Cabinet.’ It can also resolve the problem.” [UN]

Triangulating

Our respondents said that they rely on different sources and different types of information.

“We used to have a staff member whose husband worked for the Dutch government. Apparently the Europeans would get sometimes different information as well, so we should try to have as many contacts as we can.” [HUM]

“The UN does send out regular reports, but we just try to rely on other stuff as well. . . you know, try to get the local flavor of what’s going on.” [HUM]

“The head of our staff, she’s actually French with an American citizenship. At the time of the incident, her daughter was at the French school. She then got into contact with the French embassy, to see what they’re doing.” [HUM]

To have a better understanding of the situation, they collect all these different kinds of information and compare them.

“[We knew that the crisis was serious when] we started seeing people flee. Then people started consulting their contacts in the military. You know, they have their own personal contacts . . . So we try to put all these pieces together, to make sure that, you know, everything’s being consistent.” [HUM]

“We have different networks . . . When things happened during the incident, I mean those of us who have been present, we gather information all the time, to understand what’s going on. Because you don’t understand what’s going on, you have to contact all different types of people and organizations or whatever, and then you would gather information and check if it becomes a pattern, you

know, to judge what's going on. And of course our local employees, they are involved in that, but we also have those different networks that we try to reach.” [GOV]

As was apparent from the previous quotations, people rely on their network of contacts to obtain this information. Not having these close contacts could lead to information problems in a crisis.

“It depends also on your level, you know, if you are in MONUC, you know, at the level close to the DSRSG [UN Deputy Special Representative to the Secretary General in the DRC], of course you get more information. But if you're not in MONUC, and you are with an agency, again there is a problem. Anyone you talk to will tell you that there is a problem with communication in times of crisis, and with information sharing as well.” [UN]

Interaction is also important in situations with conflicting information. Respondents interact with other people to negotiate their points of view and to figure out what is really happening.

“Usually we talk with a lot of our friends, about what's going on . . . Typically there's about five of us that is here . . . We talk to our friends at UNICEF, we talk to our friends at USAID, and we talk to whoever else we can . . . We're always chatting, seeing what's related, since people fear different things.” [HUM]

“In our discussion with security leads at the embassy or whoever we would be sharing information with, we would obviously be: ‘This is what we are hearing.’ You know, trying to see why they are dismissing that information, if they are. Is it because they don't have it or is it something else? Trying to confront the two.” [HUM]

Verifying

Information that is obtained is not always accurate. Therefore, it is important to know the source of the information.

“Normally we are in the forefront of everything, because we have been in the DRC for a long time, and people do know; instinctively they come to us. When I get the first piece of information . . . we immediately look at the source, and we start the verification process.” [UN]

“They [local people] are the best advisors. They are from the country. I don't run blind; I cross-check information, but I indeed act according to their information.” [HUM]

“Deciding to go for [decide upon] a certain piece of information depends on the source, where it comes from.” [HUM]

Our respondents interact to check whether what they noticed is correct and accurate.

“There’s so much talk here. There are so many rumors in this country flying, you know, at any point. It’s really difficult to know what you can trust, what information you can trust, and what information you cannot. That’s why I try to diversify my sources. So I ask a lot of people, and you know, cross-check, and then ask people who have access to formal channels of communication and all that.” [UN]

“The local people, they notice things, and then I can check the information with the internationals.” [HUM]

They also interact to find out exactly what is happening and whether what they noticed is a threat or not.

“You can see a situation developing. Our job is to maintain staff security, so we’re constantly monitoring the political and military situation, being alert to indicators we’ve established. And sometimes you just see things: ‘Why did I see five trucks full of heavily armed soldiers going on my way home today?’ The next day I would go to the duty officer and say, ‘Look, I just saw this. What’s going on?’ And he’ll call. Once I had been downtown and seen hundreds and hundreds of people marching down the central boulevard. I called our security officer, ‘What’s going on? There seem to be hundreds and hundreds of people on the street.’ And he answered me, ‘There’s a demonstration this morning. People are on strike.’ ” [HUM]

Reflecting

Within the organization, discussions and interaction with colleagues appeared to be important.

“Normally we [colleagues] have a continuous discussion.” [HUM]

“We work as a team. In a place like DRC, you cannot work alone and take decisions alone. First of all you do not know everything yourself.” [UN]

“In such a big operation, it is important to work with a deputy. The fact that we work together is very important, amongst others to create new ideas, new thoughts, and new ways of looking at things.” [HUM]

“Very often I meet with the staff members and discuss topics before decisions are made.” [HUM]

Besides their direct colleagues, the headquarters functions as a point of reflection.

“When I’m not sure what to do, I take my telephone and call the headquarters.”
[UN]

“During March with the crisis it was helpful having internet, because we could use Skype. It was very convenient to get in touch with our head office.” [HUM]

“Headquarters in Washington, they always have somebody that’s on call, through cell phone. So that no matter what hour there’s a problem, there’s somebody that we can get a hold of.” [HUM]

3.6.3 Enacting

People act to acquire more information. But when trying to obtain more information, they change their own situation and that of the people they contact.

“I would be scared if I didn’t have information. Information gives you safety. I push people, I call to find out.” [HUM]

“You try to pass around information, you do know that there are certain types that are more important than others.” [HUM]

Time is an important factor. It forces people in a crisis to act on a plausible account of what is going on.

“It [taking into account the reaction of other people on your decisions] depends on how much time you have. If it’s about security, of course sometimes you can’t.” [HUM]

“Sometimes you have to base your decision on uncertain information because time is more important. In a crisis situation, you should react. You might react wrongly, but of course you should react in a way that doesn’t harm. [Respondent was talking about a crisis he faced.] So we shut the embassy to help the local people. If it wasn’t necessary, what do you lose? A few working hours; it doesn’t cost you very much, but if you wait it often becomes too late.” [GOV]

Respondents were talking about their needs to act in a crisis.

“When it comes down to security issues, text [SMS] is more important than voice [phone call]. It is easier to get this out to more people... Text messages are like, ‘Shooting downtown. Stay indoors.’ And it’s sent just like that, immediately. After that you can call, and then you can listen to the radio. You should keep the urgent information for the messages.” [HUM]

The communication medium should be easy to use when acting in a crisis.

“In such circumstances [crisis], what we use is essentially the telephone – because it is the more easy way of communication – but we also have other means of communication in case the telephone or the cell phone breaks down: radio communication and the internet.” [GOV]

And especially the reliability of the medium was considered of high importance when respondents needed to act.

“It doesn’t matter whether it [the communication medium] is voice or text. It should be something that works all the time. Now radios are most reliable.” [HUM]

“We also have satellite phones, that we have, but to tell you truthfully... here in Kinshasa, it’s hard to get them to work, depending what kind it is of an apartment building. When I try to get it to work, I have to get out in the middle of my lawn and hold it up in the sky... We try to have different options as much as possible.” [HUM]

“Fortunately, the mobile phone has been working during these incidents and we also have worked with radio, but that is more of internal use. But fortunately we have been able to use the mobile phone.” [GOV]

“When in locations where the local communication system is not enough, we almost always have radios.” [HUM]

Therefore respondents indicated that they use many different communication media.

“The mobile phone system is the most common way to communicate here, because there are no fixed, no landlines. Then people use SMS. We have radios, but nobody ever uses their radios... Only when things happen, you will see a higher increase in the use of radios and radio checks, and things like that.” [UN]

3.7 Discussion

In the previous section we presented our field data in which we found clear evidence of the three main Sensemaking communication activities (as shown in Figure 3.2) of (1) noticing, (2) enacting, and (3) interacting, and five specific subcategories within the latter. Moreover, all quotations on communication behavior, communication needs, and communication support in crisis situations were found to fit into one of these Sensemaking communication activities. In this section, we discuss how the communication media capabilities (as shown in Figure 3.3) can support the Sensemaking communication activities (Subsection 3.7.1), what the implications for the media synchronicity required are (Subsection 3.7.2), and how the respondents build an infrastructure for their Sensemaking communication activities (Subsection 3.7.3).

3.7.1 Sensemaking communication activities and media capabilities

Our analysis of the Sensemaking communication activity of noticing shows that the respondents make use of a wide variety of sources for their noticing activities, such as interorganizational structures, personal-based contacts, national staff members, and the news of the streets. Each source can trigger the respondents to notice a cue from the environment. The respondents also make use of many different communication channels to scan the environment and obtain relevant information, indicating that they exhibit a high level of parallelism: they keep an eye on the radio, use mobile phones, engage in face-to-face conversations, read their email, browse the internet, and so on. By doing so, they rely on many different kinds of symbol sets: visual signs such as seeing people flee, verbal communication with their personal contacts and local staff, messages on the radio, rumors that are “flying around,” written documents such as UN reports and newspapers, and written communication such as email and SMS. As it is important to find out rapidly what is going on when it concerns a crisis situation, these various symbol sets must, in MST terms, have a high transmission velocity. To summarize, noticing is characterized by high parallelism, many symbol sets, and high transmission velocity. (See Table 3.3)

Table 3.3: Information transmission media capability needs for noticing, interacting, and enacting

		Transmission Velocity	Parallelism	Symbol Sets
Noticing		High	High	Many
Interacting	Updating	High	High	Many
	Inquiring	High	Low	Few
	Triangulating	High	High	Few
	Verifying	High	Low	Few
	Reflecting	High	Low	Few
Enacting		High	Low	Few

One of the most frequently recurring observations from our interviews was the importance of the social context, as evidenced through a variety of interacting activities. Within the organization, top managers rely on their colleagues to exchange ideas and opinions, or they may fall back on advice from their headquarters. There are also organizationally established, formal mechanisms of interaction with other organizations. But besides this, most of the respondents emphasized the important role of informal contacts with people from other organizations. Especially when faced with an acute crisis situation, they relied on their informal contacts in order to obtain more information.

Since interaction is a means to an end, we made a distinction between the various goals

of interaction. First, our respondents interact to stay informed. They do this by talking to their colleagues in their own organization and in other organizations, attending meetings regularly, and consulting friends. They put a lot of effort into establishing and maintaining a network of contacts. Second, our respondents interact to inquire and obtain answers to specific questions. They mostly contact their close colleagues or friends when they want specific information or want to make use of somebody's knowledge or expertise. Third, our respondents interact to triangulate information. To create a better picture of their situation, they gather different types of information from different sources and compare it themselves or in discussion with others. Again, they rely on their personal contacts. A fourth goal of interaction is to verify the accuracy and the implication of the information they noticed or were informed about. Our respondents stressed the importance of knowing the source of the information. Fifth, our respondents interact to reflect on their situation and the decisions they have to make: They contact their colleagues to discuss the situation, to ask for their point of view, and to ask for advice on what to do. Moreover, they interact often with the head offices of their organizations.

Our respondents need a high degree of parallelism to keep in contact with the wide variety of interorganizational, intraorganizational, and informal information sources with which they interact to be updated on the situation and to triangulate information. However, when people need to (1) obtain specific information, (2) verify information, and (3) reflect on their situation, they consult only their closest contacts, the ones they trust and believe to have the expertise to help them. For these three types of interaction, a low degree of parallelism is needed. The transmission velocity, on the contrary, needs to be high for all five forms of interacting, as our respondents do not have a lot of time in crises and, thus, cannot afford to wait for messages to arrive or be delivered. When our respondents interact to be informed, they use a wide range of symbol sets, as exemplified by face-to-face meetings, email, and telephone. However, when faced with a threatening situation, they often turned to a limited number of symbol sets when consulting their sources to (1) inquire specific information, (2) triangulate information, (3) verify information, and (4) reflect on their situation and decisions. For these four types of interaction, mostly verbal communication by radio or telephone is used. The media capability needs for interacting are summarized in Table 3.3.

Our respondents communicate in crises because they want to enact on their situation and understand their enacted environment to find out what is happening. They act on a plausible, rather than an accurate, account of what is going on due to time pressure, to rapidly assess their situation. High velocity message transmissions are then needed. In addition, we found that respondents often reverted to a single communication channel while enacting. Respondents indicated that they would, for example, first send a text message and engage in verbal communication at a later time. However, what was mentioned repeatedly in the interviews is the problem of reliability of communication media. People cannot rely too much on certain media, such as mobile phones, since during a crisis the mobile network could break down. They therefore make sure other parallel channels of communication are in place in case the "main" channel fails. This indicates a need for low, yet reliable parallelism. As for interacting activities, our respondents indicated that

they revert to easy-to-use symbol sets when acting in crisis situations, such as written and verbal communication. The media capability needs for enacting are also summarized in Table 3.3.

Interpreting is the ongoing process of making sense of what is being noticed, socially constructed and enacted upon and, therefore, is a recurring theme in the other Sensemaking communication activities. As respondents continuously verify what the information means to them and their organization, messages need to be sent and understood fast when situations escalate. The least amount of time possible should be spent on encoding and decoding a message, resulting in low rehearsability and low reprocessability capabilities. However, in the crucial period before a situation escalates and when time is often limited, actors need more time to go through their communications to understand what is going on and to couch a message carefully. Since they sometimes need more time to rehearse and reprocess messages, we indicate their need for rehearsability and reprocessability as either low or medium.

3.7.2 Synchronicity of media

MST suggests that the conveyance process should be supported by a low level of media synchronicity and that this support will be accomplished with (1) low transmission velocity, (2) high parallelism, (3) few symbol sets, (4) high rehearsability, and (5) high reprocessability (Dennis et al., 2008). Sensemaking, in contrast, suggests that conveyance is an ongoing process, characterized by social interaction and enactment, which implies that low synchronicity media will not provide for the best support to reach an understanding.

Table 3.4 summarizes our findings on media capabilities for Sensemaking communication activities, together with MST's media characteristics for high and low synchronicity media. The results in Table 3.4 indicate that our respondents need a high transmission velocity for all of their Sensemaking communication activities. The degree of parallelism and number of symbol sets, however, differ across the different Sensemaking communication activities. People are in need of high parallelism in their noticing, updating, and triangulating activities; fewer communication channels suffice for inquiring, verifying, reflecting, and enacting. Respondents use a wide variety of symbol sets when noticing the environment and updating themselves about the situation, while for inquiring, triangulating, verifying, reflecting, and enacting activities, they revert back to a more limited number of symbol sets. This was especially the case when the crisis was apparent. Finally, for their interpreting activities, our respondents mostly need low-to-medium rehearsability and reprocessability media capabilities.

To summarize, our findings show that the transmission velocity, rehearsability, and reprocessability media capability needs for humanitarian managers in the DRC reflect the need for high rather than low synchronicity media support.

We can further categorize the Sensemaking communication activities according to their common information transmission media capability needs. For example, noticing and updating share the characteristics of high transmission velocity, high parallelism, and many symbol sets. Similarly, we can group inquiring, verifying, reflecting, and enacting, while

Table 3.4: Media capability findings and correspondence to synchronicity of media

		Transmission Velocity	Parallelism	Symbol Sets	Rehearsability	Reprocessability
Sensemaking Findings	Noticing	High	High	Many	x	x
	Interacting	Updating	High	Many	x	x
		Inquiring	High	Few	x	x
		Triangulating	High	Few	x	x
		Verifying	High	Few	x	x
		Reflecting	High	Few	x	x
	Enacting	High	Low	Few	x	x
MST	Interpreting	x	x	x	Low-Medium	Low-Medium
	Low Synchronicity Media	Low-Medium	Medium-High	Few-Medium	Medium-High	Medium-High
	High Synchronicity Media	Medium-High	Low-Medium	Medium-Many	Low-Medium	Low-Medium

triangulating is solely characterized by high transmission velocity, high parallelism, and few symbol sets. The common media characteristics of each respective category are labeled “scanning media” (referring to the media characteristics of the noticing and updating Sensemaking communication activities), “triangulating media” (for triangulating), and “one-to-one media” (for inquiring, verifying, reflecting, and enacting), as summarized in Table 3.5.

Table 3.5: Type of media needed to support Sensemaking communication activities

Media Types	Supported Communication Activities	Transmission Velocity	Parallelism	Symbol Sets
Scanning media	Noticing, Updating	High	High	Many
Triangulating media	Triangulating	High	High	Few
One-to-one media	Inquiring, Verifying Reflecting, Enacting	High	Low	Few

To illustrate these different media types, consider the following examples. As a scanning medium, for instance, one could think of a Web 2.0 social networking application such as Facebook with additional options (e.g., file exchange, voice-to-voice communication, and interaction through webcams). Triangulating media enable actors to consult specific sources

of information in real time, simultaneously. They allow actors to triangulate information. (A combined instant messaging and chat room application is one possibility.) Finally, a rather obvious example of a one-to-one medium is a telephone, when only one symbol set is used for direct communication between two actors with high transmission velocity.

3.7.3 Building a Sensemaking communication infrastructure

The data reveal that the foundations for the Sensemaking communication activities used in a crisis are established over a long period of time. Our respondents continuously create and maintain an infrastructure for their Sensemaking communication activities: They build up networks of work-related contacts, contacts through their own national background, friends such as internationals working in private industry, local people, and colleagues. They maintain these contacts by going to meetings, staying in touch with the embassy, going out to socially mix among the other internationals working in the DRC, and employing locals as staff members. Humanitarian actors continuously communicate with many different stakeholders, such as colleagues, other organizations, headquarters, local people, press, friends, and military. Trust is critically important in all of these activities aimed at creating a Sensemaking communication infrastructure (cf. Jarvenpaa and Leidner, 1998).

3.8 Chapter Conclusions

Analyzing communication and Sensemaking data obtained from in-depth interviews shows that humanitarian actors in the DRC engage in eight different Sensemaking communication activities: (1) noticing, (2) updating, (3) inquiring, (4) triangulating, (5) verifying, (6) reflecting, (7) enacting, and (8) interpreting.

Throughout our analysis, we have studied Sensemaking at the level where the goal of communication is to reach individual understanding rather than shared understanding. We have also observed that the communication process does not start with the sending of a message, but incorporates making sense of the situation. Studying communication processes from a Sensemaking angle therefore provides a holistic view of the communication process. Our findings also show that social interaction and enactment are vital for actors in the DRC to reach individual understanding, and that low synchronicity media will not provide for the best support in achieving this. Instead, actors will rather need high synchronicity media for these conveyance processes.

We have identified three types of media for supporting information transmission for Sensemaking communication activities: (1) scanning media, (2) triangulating media, and (3) one-to-one media.

As a consequence of the continual need to build a Sensemaking communication infrastructure, designers of information and communication systems should allow users to connect with one another. In contrast with how most systems are designed and developed, designers should not solely focus on institutional information and communication exchanges, but they should support exchanges in these mostly informal, personal net-

works. This confirms earlier findings by Turoff et al. (2009) that crisis response actors could benefit from systems that support their social networks to help alleviate information overload and assist in collaborative recommending. The scanning media example of social networking software will, for instance, enable humanitarian actors to create and maintain their important network of contacts.

The nature of involvement in the interviews and subjectivism in the analysis of the data, notably the preference for theory-driven interpretation, are shortcomings of our chosen research methodology. We tried to limit these shortcomings by conducting the interviews and analysis jointly but critiquing each other in between the interviews and giving each other feedback on the data-analysis process. In order to reduce the theory-driven interpretation, we critically analyzed the data and created new subcategories of the Sensemaking communication activities to which the data could be meaningfully assigned. As such, we tried to create a nonjudgmental involvement in the interviews. However, inherent to our approach, as we were involved in the process of collecting the data and interpreting what was said, it was not possible to obtain completely value-free data and unbiased analysis.

The focus of this research was on individual Sensemaking: the construction of meaning by individuals for which the social context plays an important role. How Sensemaking provides insights for media synchronicity when a group of individuals comes to a shared understanding remains a matter for future research.

Despite the fact that the positivist notion of statistical, sampling-based generalizability is often perceived as the only form of generalizability, the nature of generalizations is different in the interpretivist research tradition (Walsham, 1995b; Lee and Baskerville, 2003). In line with notions of generalizability in interpretive research, we have generalized our empirical descriptions to theoretical statements of rich insight and specific implications that may be valuable in other (humanitarian) crisis contexts (Klein and Myers, 1999; Walsham, 1995b; Lee and Baskerville, 2003).

Chapter 4

Group Sensemaking: The Construction of a Measurement Scale*

*All truths are easy to understand once they are discovered;
the point is to discover them.*

Galileo Galilei

Sensemaking is a process that is always going on, but is difficult to grasp and identify. In order to study the effective design of SSS, or how improved Sensemaking leads to more efficient and effective humanitarian crisis response, we need to quantify the actors' Sensemaking attainment. For this goal we set up an experimental study for which we hypothesized that group Sensemaking would play an important role (which is further described in the next chapter). From this point onwards we focus on Sensemaking in groups as opposed to Sensemaking on an individual level, as our focus is on humanitarian crisis response teams. In this chapter we investigate how to establish a reliable scale to measure group Sensemaking attainment (in accordance with research question 6). We do so through a post-experimental survey consisting of different items derived from Sensemaking literature. The answer to research question 6 is formulated in Chapter 6.

This chapter will proceed as follows. In Section 4.1 we describe our approach to capturing the concept of group Sensemaking. In Section 4.2 we review literature on social Sensemaking, ongoing Sensemaking, and Sensemaking outcomes, of which we each time identify statements which can be used to measure that particular aspect of Sensemaking. In Section 4.3 we describe how we measured Sensemaking. In Section 4.4 we discuss how we reduced our initial abundance of items to a concise set of items with high interrater reliability and non-independence, leading to a scale of items which can be filled out by individual team members and through which, as we demonstrate with Item Response Theory,

*This chapter is based to a great extent on Muhren and Van de Walle (2010b)

we can reliably order teams according to their Sensemaking attainment. In Section 4.5 we discuss our findings. Finally, in Section 4.6 we provide our conclusions.

4.1 Capturing the Concept of Group Sensemaking

There are two aspects of Sensemaking which have been qualitatively described in literature and which we can use to investigate the attainment of group Sensemaking in crisis management teams. First, among others Weick (1995) has extensively described the characteristics of the Sensemaking process, the seven Sensemaking properties, and this is one important element of measuring the attainment of Sensemaking. Second, Weick has – less concretely and more subtly – described what characterizes a “good” and “bad” outcome of Sensemaking, how this might be identified, and what its consequences could be. We call these the “Sensemaking outcomes”. In this chapter we entangle the concept of group Sensemaking by examining and measuring both the Sensemaking properties and the Sensemaking outcomes.

Research by Van Den Eede (2009) has proven Weick (1995) and Weick et al. (2005)’s reservations that the seven Sensemaking properties are not exhaustive nor mutually-exclusive. Weick (1995, p.18) therefore suggested to use the properties as “a set of raw materials for disciplined imagination”. We follow Weick’s advice and focus on two of the seven Sensemaking properties: social context (from this point onwards called “social Sensemaking”) and ongoing (from this point onwards called “ongoing Sensemaking”). There are two reasons why we specifically choose to include these two properties to measure group Sensemaking in humanitarian crisis response. First, social Sensemaking and ongoing Sensemaking are two of the most important properties for group Sensemaking in humanitarian crisis response. The social aspect of Sensemaking is of crucial importance in group Sensemaking, which is by definition characterized by social interactions. Ongoing Sensemaking is particularly relevant in humanitarian crisis response, as responders work in crisis environments characterized by interruptions, and ongoing Sensemaking is about how actors are resilient and cope with interruptions. Moreover, as previously discussed and illustrated in Figure 3.2, social context and ongoing are the only Sensemaking properties for which, when viewed from an individual perspective, both the Sensemaker and the environment play a direct role. The second reason is a deductive one: research has demonstrated that the property of identity construction is focused on the “self”, and the properties of retrospection, enactment, cue extraction, and plausibility are about the cognitive, personal “scheme” (Van Den Eede, 2009). These five other properties would therefore be influenced by the personality of the individual Sensemakers, which is beyond our present scope.

We realize the measurement of group Sensemaking by establishing a scale of survey items, through which individuals can indicate their group’s Sensemaking attainment. This scale will comprise two different types of items, all derived from literature: (1) items measuring the Sensemaking properties of social Sensemaking and ongoing Sensemaking, and (2) items measuring Sensemaking outcomes. Our approach to measure group Sensemaking is presented in Figure 4.1.

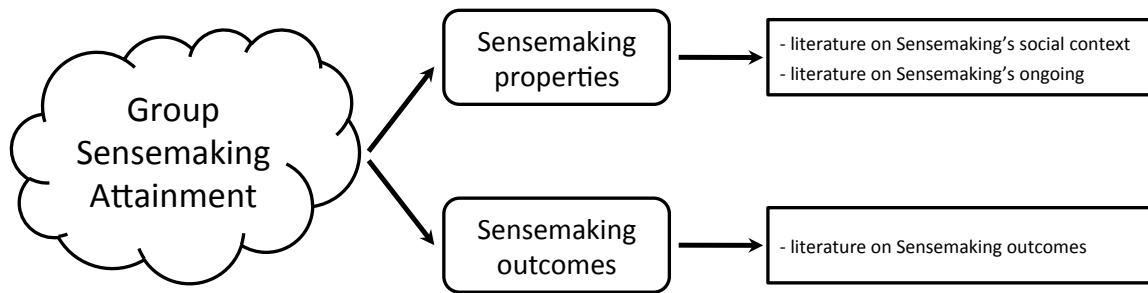


Figure 4.1: Our approach to capturing the concept of group Sensemaking

4.2 From Theory to Items

In this section we extensively examine the literature on social Sensemaking (Subsection 4.2.1), ongoing Sensemaking (Subsection 4.2.2), and Sensemaking outcomes (Subsection 4.2.3) from a Weickian perspective of Sensemaking. In each subsection we summarize relevant theory and formulate a set of statements which can be used as items to measure group Sensemaking.

4.2.1 Social Sensemaking

The social dimension is important for Sensemakers, as they try to find out what other people think and understand, and take into account other people's reactions when they act: "People learn about events when they compare what they see with what someone else sees and then negotiate some mutually acceptable version of what really happened" (Weick, 1985). Cognitive and social aspects of Sensemaking are inextricably linked. People need social anchors and a form of social reality (Weick, 2001), because what we say or think or do is contingent on what others say and think and do. Sensemaking requires talking, interaction, conversation, argument, and dialog with others (Nathan, 2004), and teams offer a place for the talking, arguing, and interpretation that is necessary for making sense of things (see Chapter 3 and Ashmos and Nathan, 2002). As Weick (1993) explains, "perhaps it's more important that you have a partner than an organization when you fight fires. A partner makes social construction easier. A partner is a second source of ideas. A partner strengthens independent judgment in the face of a majority. And a partner enlarges the pool of data that are considered."

Sensemaking is relational (Weick, 2005), as people need social anchors and a form of social reality (Weick, 2001). Social influences on Sensemaking do not arise solely from physical presence. Conduct is contingent on the conduct of others, whether those others are imagined, implied or physically present (Weick, 1995, 2001): "Other people are integral to our efforts to make sense of things because what we say or think or do is contingent on what others say and think and do. Even if we are alone, we imagine the response of others to our actions or thoughts, and adjust our thinking and behavior

accordingly” (Nathan, 2004). As we have discussed previously in Chapter 3, our study of humanitarian managers’ Sensemaking activities in the DRC exemplified the necessity of the presence of other people for Sensemaking. The study showed that people need a network of (informal) contacts, with whom they interact to stay informed, to inquire and obtain answers to specific questions, to triangulate information, to verify the accuracy and the implication of the information they noticed or were informed about, and to reflect on their situation and the decisions they have to make. With a higher presence of other people, particularly in the case of requisite variety when there are people with diverse experiences, the variety of measures used by the group to make sense of equivocal events can increase (Weick and Meader, 1993). Moreover, with a higher presence of others there is more opportunity to learn vicariously of others’ experience (Nathan, 2004), as the Sensemaking property of retrospect highlights. When there is a low presence of others, when social anchors disappear and one feels isolated from a social reality of some sort, one’s grasp of what is happening begins to loosen (Weick, 2001).

Summary: for social Sensemaking it is important

1. to be able to fall back on other group members for information, questions, feedback, and reflection;
2. to use a communication medium which encourages discussion between group members;
3. not to lose social anchors and feel isolated from a social reality of some sort.

Sensemaking is interactive (Weick, 2005): talk, discourse, and conversation are important for Sensemaking, as that is how a great deal of social contact is mediated (Weick, 1995). Therefore, the organizational form should allow for more conversations (Weick, 2001) and encourage conversation (Weick, 2001). More active participation by group members allows for more discussion of contrary views: It brings contrary interpretations to the surface, which can then make the group’s interpretation more stable and implementable once it is constructed (Weick and Meader, 1993). Aids that discourage conversation undercut the social foundation of Sensemaking (Weick and Meader, 1993).

Summary: for social Sensemaking it is important

4. to discuss in the group;
5. to allow for as much discussion as possible;
6. for all group members to participate actively.

The quality of interconnectivity within a group affects the quality of representations constructed by members, the degree of intelligence manifest by a network of nodes (Weick, 2005). This quality of interconnectivity is about how careful people interrelate different pieces of information. Weick argues that this should be done heedfully, i.e., more carefully,

critically, consistently, purposefully, attentively, studiously, vigilantly, and conscientiously (Van Den Eede, 2009). “The basic idea in heedful interrelating is that a collective mind capable of varying degrees of intelligence emerges as a kind of capacity in an ongoing activity stream when activities among people are tied together as contributions that constitute and are subordinated to a joint system. The mind is more fully developed if those interrelations occur with greater heedfulness” (Weick, 2005). Variations in interconnection produce variations in the representations that are synthetically constructed, suggesting that different network forms have different cognitive consequences. Some network forms may produce ignorance, tunnel vision, and normalizing, whereas other forms may produce novel insights, original syntheses, and unexpected diagnoses (Weick, 2005).

People learn about an event when they apply several different measures, each of which has a different set of flaws (Weick, 1985). Therefore, comparison, negotiation, and free exchange of ideas are important processes for Sensemaking. It is important to increase the ability of participants to build a common set of linkages, preferences, and interpretations (Weick and Meader, 1993).

Summary: for social Sensemaking it is important

7. to compare critically different pieces of information to each other;
8. to consider carefully all information inputs;
9. to focus on the contrary views within the group.

4.2.2 Ongoing Sensemaking

Sensemaking is ongoing, and has neither a beginning nor a formal end. Instead, it “takes place in a continuing and dynamic fashion as events unfold and we continually seek to understand what events mean in relationship to our organizations” (Nathan, 2004). To understand Sensemaking is to be sensitive to the ways in which people chop moments out of continuous flows and extract cues from those moments (Weick, 1995). Most of us at any given time find ourselves “in the middle of something”. Sensemaking is constrained not only by past events, but also by the speed with which events flow into the past and interpretations become outdated. As we move from one situation to another, we make and revise assumptions and beliefs along the way. Once you cannot keep pace with the action, you lose context, information, situated cognition, and tools made meaningful by actual use (Weick, 2005).

Summary: for ongoing Sensemaking it is important

10. that the decision making process is smooth and continuous;
11. to understand from each other in the group what group members are thinking or doing;
12. for group members to contribute to the discussion when they want to.

Sensemaking is affected by interruptions, signals that important changes have occurred in the environment, in the ongoing stream of experience (Weick, 1995). “Whenever an expectation is disconfirmed, some kind of ongoing activity is interrupted. Thus to understand Sensemaking is also to understand how people cope with interruptions” (Weick, 1995, p.5). Sensemaking is enhanced if there is more focused attention on interruptions whenever projects are disrupted; when people lose the ability to focus on interrupting conditions, they begin to lose their grasp of the situation (Weick, 2001).

“Sensemaking is about labeling and categorizing to stabilize the streaming of experience” (Weick et al., 2005). Labeling works through a strategy of “differentiation and simplification, identification and classification, regularizing and routinization [to translate] the intractable or obdurate into a form that is more amenable to functional deployment” (Weick et al., 2005). Important in this definition is “functional deployment,” as Weick et al. (2005) explain: “In medicine, functional deployment means imposing diagnostic labels that suggest a plausible treatment. In organizing in general, functional deployment means imposing labels on interdependent events in ways that suggest plausible acts of managing, coordinating, and distributing”.

What we can understand from this, is that labeling and categorizing ensure “functional deployment” – plausible acts of organizing – and stabilize the ongoing stream of experience. On the contrary, if people lose the ability to bound ongoing events or if ongoing events become more resistant to bounding (Weick, 2001), Sensemaking becomes more difficult. What we should be careful for, is that resorting to absolute categories may ignore large pieces of continuity, thereby entrapping us in misconceptions (Weick, 1995).

Summary: for ongoing Sensemaking it is important

13. to pay extra attention to situations in which expectations or beliefs are disconfirmed;
14. to be able to focus the group’s attention to the issues one wants to discuss;
15. to translate an unclear situation into a situation in which it is more understandable what is going on.

The goal for successful Sensemaking is to stay in the action by means of prompt repair and recovery after interruption. If instead people pull away and adopt a detached, atomistic view or analyses after interruption, they lose context, information, situated cognition, and tools made meaningful by actual use (Weick, 2005). “As we move from one situation to another, we make and revise assumptions and beliefs along the way. (...) We work at making sense of past events to develop a story that we understand, and as future events unfold we revise our story” (Nathan, 2004). Therefore, the organizational form should enable people to be resilient in the face of interruptions (Weick, 2001). If an interrupting stimulus is suddenly and unexpectedly removed, positive emotion occurs (Weick, 1995). In contrast, when people lose the ability to keep pace with ongoing events by means of continuous updating of actions and interpretations, they begin to lose their grasp of the situation (Weick, 2001).

Summary: for ongoing Sensemaking it is important

16. to react swiftly to an unclear situation in order to create a more understandable picture of the situation;
17. to update actions and interpretations continuously according to new information;
18. for group members not to pull away and adopt a detached, atomistic view or analysis after an interruption.

4.2.3 Sensemaking outcomes

In Sensemaking literature, there are several indications of the outcome of Sensemaking. Sensemaking is said to impact what people *know*, about the situation, what to do, and what will follow. Weick gives an example of somebody who is successful in Sensemaking, because "... he gives his crew a direction for some indefinite period, a direction which by definition is dynamic, open to revision at any time, self-correcting, responsive, and with more of its rationale being transparent" (Weick, 2005). Based on Weick's work, Nathan (2004) argues that "the desired end result of Sensemaking is first and foremost that people would hold a better understanding of the uncertainties they face as they look upon the future".

Summary:

19. good Sensemaking outcome is characterized by having a good idea of which direction to follow;
20. good Sensemaking outcome is characterized by having a good understanding in the group of the uncertainties that are faced.

Sensemaking has an impact on what people *can do*. Weick argues that organizations must be designed to "develop a coherent story of what is going on (...) These effects of design on resources for Sensemaking, in turn, make it easier or harder to build a common idea of what is happening and what decisions need to be made" (Weick, 2001).

Summary:

21. good Sensemaking outcome is characterized by being able to develop a coherent story in the group of what is going on;
22. good Sensemaking outcome is characterized by being able to develop a common idea in the group of what is happening.

Sensemaking subsequently impacts what people *actually do*. "These seven properties affect not only the initial sense one develops of a situation – this initial sense is often overdetermined by one's own personal history – but more importantly, the extent to which people will update and develop their sense of the situation. (...) These properties

have an effect on the willingness of people to disengage from, discard, or ‘walk away’ from their initial story and adopt a newer story that is more sensitive to the particulars of the present context” (Weick, 2001). But the actions come with further consequences, as is apparent from Weick (1985), “if people stick to one view [of what they made sense], their lives may be momentarily more soothing, but also become more susceptible to sudden jolts of disconfirmation” and Weick (2001), “variations in [the organizational design that affects] Sensemaking, in turn, affects enthusiasm, the willingness to sustain complex collaboration, and resourcefulness in the face of setbacks.”

Summary:

- 23. good Sensemaking outcome is characterized by updating and developing the group’s initial sense of the situation;
- 24. bad Sensemaking outcome is characterized by sticking to one view of what is happening;
- 25. good Sensemaking outcome is characterized by being resourceful in the face of setbacks.

Finally, Sensemaking has an effect on *what happens*. Bad Sensemaking results in an “incidence of senselessness” (Weick, 1985), and in which subsequently “one’s grasp of what is happening begins to loosen” (Weick, 2001). This impacts how one feels, and is an important goal of Sensemaking: “The *feeling* of order, clarity, and rationality is an important goal of Sensemaking” (Weick, 1995, p.29).

Summary:

- 26. bad Sensemaking outcome is characterized by experiencing a total lack of meaning of what is happening;
- 27. bad Sensemaking outcome is characterized by losing the group’s grasp of what is happening;
- 28. good Sensemaking outcome is characterized by having the feeling of order, clarity, and rationality.

4.3 Research Methodology

All 28 statements were transformed into survey items, with the resulting 28-item survey presented in Appendix B (page 145). We labeled each item with an “itemID”, which will be referred to in Section 4.4. All items have answer options on a 5-points Likert scale, in decreasing order of agreement to the respective statement: “Strongly Agree”, “Agree”, “Neutral”, “Disagree”, and “Strongly Disagree”. In order to minimize response-set bias, some items are negatively worded and others are positively worded.

The items were tested on 144 international students who participated in a group decision making experiment at Tilburg University in Spring 2010. More information on this

experiment is given in the next chapter. To understand the context surrounding the survey, we briefly mention the most important details of the experiment. Students were assigned to 48 random groups of three, and worked for about an hour on a floods crisis response case in which they had to reach an agreement in their group on which district to provide first (priority) humanitarian assistance to. The participants each received different sets of needs assessment information on the affected districts, and had to discuss their findings and compare it with the other team members' information. After the participants had reached a group decision, group members were asked to answer the survey with the Sensemaking items, which they had not seen before, in a separate cubicle, and were not able to communicate with their group members when responding to the items. The survey was programmed with Zurich Toolbox for Readymade Economic Experiments (z-Tree), software for experimental economics. Because we programmed all items as required fields in z-Tree, we do not have any missing data.

4.4 Data Analysis

The responses to negatively worded items are reversed so that a positively-oriented score is obtained for all items: a higher score implies a higher Sensemaking attainment. The descriptive statistics of the (reversed) survey responses are listed in Table 4.1, where the descriptive statistics of the individual responses are displayed on the left, and the descriptive statistics of the three individual responses aggregated for each group are displayed on the right. The most difficult item (i.e., least popular) is ongoing9 with a mean value of 0.910, and the easiest item (i.e., most popular) is social6 with a mean value of 3.285.

As we wish to use the aggregate responses to compare groups according to their Sensemaking attainment, the first step in the analysis is to find out whether individual responses can be used to say something about the group's behavior. When each individual in a group rates their group's behavior, it is logical to assume that the aggregate of the individual responses provide for a more reliable measure of the group's behavior than each individual response, as the aggregate measures may increase the ability to measure subtle group phenomena (Bliese, 2000). In multilevel modeling and analysis, in which data on lower and higher levels are compared to each other, it is a commonly investigated question whether it is justified to aggregate individual responses. This is assessed by exploring the interrater reliability and non-independence of the individual responses in Section 4.4.1. In Section 4.4.2 we investigate whether we can establish a set of items through which groups can be ordered according to their Sensemaking attainment.

4.4.1 Interrater reliability and non-independence

The Intraclass Correlation Coefficient (ICC)(1) estimates the effect size, indicating the extent to which individual responses are attributable to group membership. The measure of this effect size is accompanied by an F-test, which tests whether the between-group variance of the responses is significantly greater than the within-group variance of the

Table 4.1: Descriptive statistics of the Sensemaking survey items

Sensemaking item	Individual responses (N=144)				Responses aggregated by group (N=48)			
	Min.	Max.	Mean	Std.Dev.	Min.	Max.	Mean	Std.Dev.
social1	0	4	2.938	0.910	1.67	4.00	2.938	0.570
social2	0	4	2.639	1.075	0.33	3.67	2.639	0.690
social3	0	4	2.917	1.119	1.33	4.00	2.917	0.672
social4	0	4	2.840	1.001	1.33	4.00	2.840	0.603
social5	0	4	1.951	1.118	0.00	3.33	1.951	0.734
social6	0	4	3.285	0.808	2.00	4.00	3.285	0.510
social7	0	4	3.174	0.814	2.00	4.00	3.174	0.451
social8	0	4	2.743	1.029	0.67	3.67	2.743	0.646
social9	0	4	2.757	0.970	1.33	4.00	2.757	0.540
ongoing1	0	4	3.042	0.900	1.33	4.00	3.042	0.625
ongoing2	0	4	2.938	1.032	1.33	4.00	2.938	0.647
ongoing3	0	4	3.278	0.848	1.67	4.00	3.278	0.488
ongoing4	0	4	2.736	0.975	1.00	3.67	2.736	0.571
ongoing5	0	4	2.736	1.003	1.33	3.67	2.736	0.523
ongoing6	0	4	2.903	0.822	1.33	3.67	2.903	0.456
ongoing7	1	4	3.056	0.707	2.00	4.00	3.056	0.420
ongoing8	0	4	3.208	0.747	1.67	4.00	3.208	0.427
ongoing9	0	4	0.910	0.756	0.00	2.33	0.910	0.433
outcome1	0	4	3.278	0.733	2.00	4.00	3.278	0.442
outcome2	0	4	3.007	0.789	2.00	4.00	3.007	0.427
outcome3	0	4	3.049	0.769	2.00	3.67	3.049	0.446
outcome4	0	4	2.549	1.133	1.00	4.00	2.549	0.696
outcome5	1	4	3.181	0.665	2.00	4.00	3.181	0.456
outcome6	0	4	2.500	1.024	1.00	3.67	2.500	0.611
outcome7	0	4	2.229	1.114	0.33	3.33	2.229	0.722
outcome8	0	4	2.389	1.025	0.67	3.33	2.389	0.699
outcome9	1	4	2.625	0.678	1.67	3.33	2.625	0.387
outcome10	0	4	3.132	0.847	1.00	4.00	3.132	0.574

responses. For more information on how ICC(1) values and related F-tests are calculated, the interested reader is referred to Appendix C (page 151). For the interpretation of effect sizes, Murphy et al. (2009) recommend adhering to the usual convention that an effect size < 0.01 is a small effect, and an effect size between 0.01 and 0.05 is a small to medium effect. Bliese (2000) typically sees values in his U.S. Army data between 0.05 and 0.2, and would be surprised to find ICC(1) values greater than 0.30 in most applied field research.

Table 4.2 lists all ICC(1) values and related F-tests for our survey items. The ICC(1) values we observe for the Sensemaking items range from -0.091 (ongoing5) to 0.222 (ongoing1), with an average of 0.055. One item has a small effect ($\text{ICC} < 0.01$), 6 items have a small to medium effect ($0.01 < \text{ICC} < 0.05$), 5 items have a medium effect ($0.05 < \text{ICC} < 0.1$), and 7 items have a relatively large effect ($\text{ICC} > 0.1$). We also note that 9 items have a negative ICC(1) value, indicating that the between-group variance is smaller than the within-group variance. Although these so-called “frog-pond situations” might be of theoretical interest to some researchers (Bliese, 2000), it is not of interest to our objective of establishing a Sensemaking measurement scale in which individuals can meaningfully indicate their group behavior.

More interestingly than the ICC(1) values itself, is the F-test for the different items which indicates whether the between-group variance is significantly greater than the within-group variance. Remarkably, with $p < 0.05$, we can see in Table 4.2 that only five items meet our criteria for which we can reject the F-test’s null-hypothesis (defined in Appendix C): social5, ongoing1, outcome5, outcome8, and outcome10 are the only items for which the variance within groups is significantly smaller than the variance between groups. In other words, we can state that group membership affects individuals’ responses for these five items, but not significantly for all other items. As group membership *should* play an important role in individuals’ responses to items concerning group behavior (group Sensemaking), we can only continue our analysis with the social5, ongoing1, outcome5, outcome8, and outcome10 items.

4.4.2 Item response scale analysis

To design and analyze a reliable measurement scale for Sensemaking we use Mokken (1971)’s Model of Monotone Homogeneity (MHM) from Item Response Theory (IRT), commonly used in psychometrics to assess unobservable mental abilities and mental attributes. Mokken scale analyses is a nonparametric probabilistic version of the Guttman scalogram (Guttman, 1950), with which one can create a scale to order people on a specific latent ability or latent trait. The success probability for a fixed item depends on the person’s ability or trait level and is called its Item Response Function (IRF). It is assumed that this IRF increases if the person has more of the latent ability or latent trait. Our objective is to investigate whether all or a selection of the remaining Sensemaking items fit Mokken’s MHM, which will enable us to order teams according to their Sensemaking attainment. In other words, group Sensemaking is our latent trait, on which we want to rank order the groups. The interested reader is referred to Appendix D (page 152) to read more about IRT and Mokken’s nonparametric MHM scale analysis.

Table 4.2: ICC(1) values and related F-tests for all Sensemaking survey items

Item	ICC(1)	F-test for true value 0	
		Value	Significance
social1	0.087	1.287	0.149
social2	0.118*	1.401	0.083
social3	0.041	1.128	0.306
social4	0.044	1.140	0.291
social5	0.146**	1.512	0.045
social6	0.097	1.321	0.126
social7	-0.039	0.887	0.671
social8	0.090	1.297	0.142
social9	-0.034	0.901	0.649
ongoing1	0.222***	1.855	0.005
ongoing2	0.089	1.293	0.144
ongoing3	-0.004	0.989	0.507
ongoing4	0.014	1.043	0.422
ongoing5	-0.091	0.749	0.863
ongoing6	-0.038	0.889	0.668
ongoing7	0.029	1.089	0.356
ongoing8	-0.009	0.974	0.530
ongoing9	-0.007	0.978	0.524
outcome1	0.045	1.141	0.290
outcome2	-0.061	0.828	0.762
outcome3	0.003	1.009	0.474
outcome4	0.065	1.210	0.214
outcome5	0.202***	1.761	0.010
outcome6	0.034	1.105	0.335
outcome7	0.128*	1.442	0.066
outcome8	0.196**	1.730	0.012
outcome9	-0.012	0.964	0.546
outcome10	0.188**	1.696	0.015

*** F-test is significant at the 0.01 level (one-tailed)

** F-test is significant at the 0.05 level (one-tailed)

* F-test is significant at the 0.1 level (one-tailed)

We use the “MSP5” software package for our scale analysis, which is the only program available to run Mokken’s nonparametric MHM scale analysis. The aim of our analysis is to verify whether the five remaining items can form one scale to measure one latent trait: group Sensemaking. The ICC(1) analysis has revealed that the individual responses to these five items are influenced by group membership, and that it is therefore allowed to aggregate the individual responses to construct the group responses. The drawback of MSP5 is that the program only accepts integers from 0 until 9 as responses to each item. The average is therefore not a good aggregate measure to use in this analysis for the group’s responses, as in many cases we would need to round the group responses to integers of 0 until 4. If we take the sum score as the aggregate measure for the group’s responses, the response range is from 0 until 12. We examine the distribution of the responses for the latter strategy, which can be found in Table A.1 of Appendix E (page 154). If we want to take the sum score as the aggregate measure, we need to join four response categories into one across all items. As the data are skewed more towards higher sum scores, we investigate what happens when we join the four lowest response categories. The new distribution of responses can be found in Table A.2 of Appendix E. Because the distribution of responses is only slightly changed, the MHM assumption that the answer categories of the items need to have a meaningful order representing increasingly higher levels of the latent trait still holds. Moreover, the interpretation of the responses remains intuitively easy to understand (the lowest response category represents groups who had the lowest score for that particular item). Therefore, we choose to continue the MHM analysis with the sum score of the groups as represented in Table A.2 of Appendix E.

Sijtsma and Molenaar (2002) designed a goodness-of-fit analyses based on Mokken (1971)’s work, with which one can derive observable consequences from the mathematical formulation of the MHM. The MHM is based on three important assumptions.

- *Local independence*: there should be no learning or any other kind of development relevant to item performance during test taking;
- *Unidimensionality*: the items in the test are driven by one latent trait only;
- *Monotonicity*: people, or in our case groups, are expected to produce higher scores the higher their latent trait level.

The MHM requires the data to comply with these assumptions, and there are three observable consequences to check whether these assumptions hold in the data. The first observable consequence of the MHM is that the covariances between items should be non-negative. Second, each Item Step Response Function (ISRF) that is estimated from the data should be non-decreasing. Third, the quality indices for MHM scales – the scalability coefficients H_i , H_{ij} , and H – should be checked.

The first part of our MHM analysis is to check the covariances between all item pairs, as presented in Table 4.3. Mokken (1971) proved that if the assumptions of local independence, unidimensionality, and monotonicity hold in the data, all pairs of items are non-negatively correlated. All covariances between item pairs appear to be nonnegative.

Table 4.3: Bivariate Pearson correlations of all item pairs

		social5	ongoing1	outcome5	outcome8	outcome10
social5	Correlation	1				
	Significance					
ongoing1	Correlation	0.272*	1			
	Significance	0.061				
outcome5	Correlation	0.107	0.579***	1		
	Significance	0.468	0.000			
outcome8	Correlation	0.430***	0.509***	0.244*	1	
	Significance	0.002	0.000	0.095		
outcome10	Correlation	0.298**	0.788***	0.566***	0.431***	1
	Significance	0.039	0.000	0.000	0.002	

*** Correlation is significant at the 0.01 level (2-tailed)

** Correlation is significant at the 0.05 level (2-tailed)

* Correlation is significant at the 0.1 level (2-tailed)

Next, we analyze the data with MSP5, of which the most important output is presented in Appendix F. We have verified that there are no significant decreases in the ISRFs, which supports the assumption of latent monotonicity. Because this is a technical discussion, we refer the interested reader to a further clarification in Appendix F.

For the last part of our analysis we examine the scalability coefficients. From a theoretical point of view, the scalability coefficients are not allowed to be negative under the MHM, and any item, item pair, or scale with a nonnegative H-value is acceptable (Sijtsma and Molenaar, 2002, p.36). However, small H-values indicate positive but weak discrimination power. Therefore, practically, item scalability coefficients greater than 0.3 are required (Mokken, 1971, p.185). In the “overview final scale”, as presented in Table 4.4, we can observe that none of the items have negative H-values, that all item H-values are significantly larger than 0, and that all item H-values are larger than the lowerbound criterion of 0.3. This indicates that all items are good indicators of the underlying construct, and supports the MHM. Because we observe that all H-values for the item pairs are nonnegative, and the scale H-value is 0.46, we may consider these five items to form a medium to strong scale for accuracy of ordering persons by means of total sumscores on one latent trait (Sijtsma and Molenaar, 2002; Mokken, 1971), which is in our case group Sensemaking.

Table 4.4: Item coefficients from MHM scale analysis

Item ID	Item	Mean	Item H-value	Z-score
social5	I would have wanted to discuss more than we actually did.	2.98	0.32	3.97
ongoing1	The decision making process in our group was smooth and continuous.	6.12	0.56	7.12
outcome5	In our team, we updated and developed our initial sense of the situation.	6.54	0.39	4.98
outcome8	In our team, our grasp of what was happening sometimes began to loosen.	4.19	0.44	5.64
outcome10	In our team, we had the feeling of order, clarity, and rationality.	6.40	0.56	6.96

Scale coefficient $H = 0.46$

Scale Z-score = 9.02

4.5 Discussion

We started the construction of our measurement scale with 28 items grounded in Weick's Sensemaking theory to measure group Sensemaking in crisis management. Out of these 28 items, nine items were specifically aimed at measuring social Sensemaking, nine items at ongoing Sensemaking, and ten items at measuring Sensemaking outcome. However, we had to exclude most of these items after our intraclass correlation analyses of reliability and non-independence. An important question to answer is why many items had to be eliminated in this shift. We present several reasons for this.

ICC(1) values are not biased by either group size or the number of groups in the sample (Bliese, 1998; Bliese and Halverson, 1998), which makes them directly comparable across studies. However, the significance of the F-test for ICC(1), which we used to determine whether there is a significant group effect, is influenced by the number and size of the units in a sample (Klein et al., 2000), as the degrees of freedom for the F-statistic are sample dependent (McGraw and Wong, 1996; Shrout and Fleiss, 1979). When compared to other studies, such as by Ostroff on the influence of satisfaction on turnover intentions with data collected from 13,808 teachers from about 350 schools (Bliese, 2000), or the influence of work hours on psychological well-being with data collected from 7,382 respondents from 99 U.S. Army Companies (Bliese and Halverson, 1998), we may consider our study with 144 individuals in 48 teams a relatively small sample. In our case one individual can cause a relatively large within-group variance of the team, and this can cause a non-significant group effect for a particular item if this happens in a few teams concerning the same item.

In search for other explanations of the rejection of most of the items, we refer back to the ICC(1) calculations. Low ICC(1) values are the result of low consensus within groups, low consistency, or both (LeBreton and Senter, 2008). For most of the items, the ICC(1)

value was not significantly larger than 0, and in some cases even negative, indicating a large degree of variance within groups and/or a great deal of homogeneity in group means. This implicates that either (1) there was a large degree of difference between the individual perceivements of the group's behavior, or (2) the item was not suitable to discriminate between the different group behaviors.

In the first case, the problem could have been that the wording of the items was not clear or that it was too difficult for individuals to relate the question to their group process. Although it is possible that either one of these reasons was the problem for some of the items, the most reasonable explanation is that many items were too subjective to represent the behavior of the group. Although we excluded the most subjective properties of Sensemaking in the construction of this scale, the items remain subjective in nature. We required the respondents to give their subjective view on the group process, and apparently individuals within groups did not always consistently rate their Sensemaking behavior. This is a more general problem of trying to measure subjective criteria, and is possibly resolved when using larger group sizes.

In the second case, the mean group responses were too homogeneous, indicating that the item might characterize an aspect of Sensemaking which was either good for most of the teams, or bad for most of the teams. This concurs with a closer look at the standard deviations of the aggregated items, as shown in the right part of Table 4.1. The average standard deviation of the mean for the nine items with negative ICC(1) values (Table 4.2) is 0.459 and for the seven items with small to medium ICC(1) value it is 0.538, while the average standard deviation of the mean for the five items in the final scale is 0.618. The between-group variance of the rejected items appeared to be too small to compensate for the within-group variance.

Because the ICC(1) value measuring effect size is reasonably large for social5, ongoing1, outcome5, outcome8, and outcome10, and significantly greater than 0, aggregation of individual responses to these items into group responses is warranted (Bliese, 2000; Klein et al., 2000; LeBreton and Senter, 2008). Because the observable consequences of the MHM were satisfied in the data, we may include all five items in our final group-Sensemaking-in-humanitarian-crisis-response measurement scale. The final 5-item scale is presented in Table 4.5. These five items represent the (1) *effective use of social resources*, (2) *flow of the group process*, (3) *elaboration on initial situation awareness*, (4) *control of situation*, and (5) *perceived comprehensibility*. We recommend using the average group responses as an aggregated measure for each item. The descriptive statistics of our aggregated item responses can also be found in Table 4.5. If these averages of all five items are summed together, one can reliably order groups according to their Sensemaking attainment (Cronbach $\alpha = 0.768$).

If we subsequently apply this scale to our data of 48 teams, we obtain a scale in which the lowest group Sensemaking attainment in the experiment is rated with a score of 6.667 and the highest 17.333, with a mean of 13.694 and a standard deviation of 2.251 (see Chapter 5).

Table 4.5: The five group Sensemaking in humanitarian crisis response measurement scale variables, with the descriptive statistics of the aggregated responses

Group Sensemaking variable	Mean	St.Dev.	Min.	Max.
Effective use of social resources I would have wanted to discuss more than we actually did.	1.951	0.734	0.00	3.33
Flow of the group process The decision making process in our group was smooth and continuous.	3.042	0.625	1.33	4.00
Elaboration on initial situation awareness In our team, we updated and developed our initial sense of the situation.	3.181	0.456	2.00	4.00
Control of situation In our team, our grasp of what was happening sometimes began to loosen.	2.389	0.699	0.67	3.33
Perceived comprehensibility In our team, we had the feeling of order, clarity, and rationality.	3.132	0.574	1.00	4.00

4.6 Chapter Conclusions

Sensemaking is usually abstractly used in literature and practice, and consequently difficult to get a grasp of and to quantify. In this chapter we presented a five-item scale to measure group Sensemaking in crisis management, based on Weick's perspective of Sensemaking and tested in student teams after a humanitarian crisis response experiment. This scale can form the basis of a new era in research on Sensemaking in humanitarian crisis response teams, as it is the first attempt to measure Sensemaking. By using this scale, teams can be rank ordered according to their Sensemaking attainment, and researchers can study this Sensemaking attainment either as dependent or independent variable.

There are two limitations of this research. First, although we have verified that the observable consequences of MHM are satisfied in our data, it does not prove the model to be correct. If these observable consequences are not satisfied in the data, the model is rejected, but our analysis only supports the model. Second, there is a need for validation of our scale, preferably in real-life crisis management teams. Future research should ideally use a larger sample size and larger group sizes in an attempt to validate our rejected Sensemaking items. An important direction for future research is the study of how information systems can optimally support Sensemaking attainment in humanitarian crisis management teams. With our group-Sensemaking-in-humanitarian-crisis-response measurement scale, research can be concretely directed at designing SSS in these contexts.

Chapter 5

Group Sensemaking: The Hidden Factor in Group Decision Making*

*No amount of experimentation can ever prove me right;
a single experiment can prove me wrong.*

Albert Einstein

This chapter presents an experimental study on group decision making in humanitarian response teams, for which we quantitatively examine the role of Sensemaking. The setup of the experiment is largely grounded on the authors' participant observation experiences in a humanitarian response exercise. The aim of the chapter is to find additional answers to research question 3 and to answer research question 7 and research question 8. The answers to the research questions are formulated in Chapter 6.

The chapter is outlined as follows. In Section 5.1 we describe the reality of humanitarian crisis response teams, including our observations of information management procedures and Sensemaking support during the Triplex exercise on which the experiment is based. Section 5.2 is dedicated to discussing theory on group decision making and information processing, as is relevant to our experimental study. In Section 5.3 we present our conceptual research model and formulate research hypotheses. In Section 5.4 we describe the method of research, the hidden profile experimental study designed according to our experiences in the Triplex exercise, including the results of two pilot experiments which we conducted. In Section 5.5 we continue with the presentation of the results and their implication for the different hypotheses. In Section 5.6 we finalize the chapter with discussion and conclusions.

*This chapter is based to a great extent on Muhren and Van de Walle (2009) and Muhren and Van de Walle (2010c)

5.1 Information Management in Humanitarian Crisis Response: The Triplex Exercise

In response to large-scale humanitarian crises, UN OCHA has the mandate to mobilize, direct, and coordinate international assistance¹. The United Nations Disaster Assessment and Coordination (UNDAC) system is part of OCHA and is designed to assist the UN in the coordination of incoming international relief at the site of the emergency and in providing information during the first phase of a sudden-onset emergency (United Nations, 2006). In the last 15 years, UN OCHA deployed an UNDAC team to around 200 missions, recently, among others, to the earthquakes in Haiti and Pakistan, the floods in Nepal, Honduras, and Panama, and the cyclone in Myanmar. UNDAC does not deliver humanitarian assistance, but provides support through on-site coordination, emergency assessment, and information collection and dissemination (United Nations, 2006).

In situations combining a high number of humanitarian actors and a rapidly evolving emergency situation requiring a high degree of coordination, the UNDAC team sets up an OSOCC for the coordination of the operational activities undertaken by humanitarian organizations, including UN agencies, the government, and NGOs. Information management is a core activity in UNDAC missions. In the UNDAC Field Handbook, the task of information management is defined as to “compile and analyze the information input from outside sources (...) and convert it into appropriate output format for dissemination to stakeholders” with the expected result of “provision of timely output of analyzed information in appropriate format” (United Nations, 2006, Chapter E, p.18). Among others this information management aspect of UNDAC missions is exercised at Triplex.

Triplex is a biennial humanitarian exercise organized by the International Humanitarian Partnership, a voluntary international cooperation which provides support for international humanitarian operations. In September 2008 the Triplex exercise took place during three days in the border area of Norway and Sweden.

The exercise was based on a floods scenario, which affected both Eastlandia and Westlandia – two countries which had been created for the purpose of the exercise. In reality, Westlandia corresponded to Østlandet region in Norway and Eastlandia corresponded to Värmland County in Sweden. Westlandia and Eastlandia were two very different countries: Westlandia was a medium developed and peaceful country with high involvement of international organizations, while Eastlandia was an autocratic and low developed country, engaged in internal conflicts and generally hostile to foreign assistance. The area bordering Westlandia and Eastlandia was inhabited by Morokuliens, a minority and economically less-developed group in both countries. The scenario combined both seasonal flooding and flash flooding. Triplex was organized as realistically as possible, with participants staying in an actual base camp and using vehicles and communication equipment as in an actual field operation. Moreover, Norwegian and Swedish municipalities were actively participating in the exercise by playing their role as local authorities and affected population.

¹United Nations General Assembly GA Resolution 2816 (XXVI) of 14 December 1971

In Subsection 5.1.1 we describe the research methodology we used at the Triplex exercise. Next (Subsection 5.1.2), we present our observations of humanitarian information management practices at the Triplex exercise, specifically regarding the needs assessment process. Finally, in Subsection 5.1.3 we discuss our findings from a Sensemaking support perspective.

5.1.1 Research methodology

During the Triplex exercise we² were embedded in Belgian First Aid and Support Team (B-FAST). Together with another B-FAST team member we were delegated to join the UNDAC team as information managers in the OSOCC. We had the task to evaluate the new joint needs assessment process that was tested in this exercise. For this reason we were working in the OSOCC and always present at the debriefings of the assessment teams. To get an accurate picture of the assessment process we also joined a team to conduct assessments. This gave us the opportunity not only to observe the phenomena we were interested in, “the fundamental base of all research methods in the social and behavioral sciences” (Angrosino, 2005), but also to conduct a specific form of observation: participant observation (DeWalt and DeWalt, 2002). Participant observation originated in cultural anthropology and is now a commonly used method in social sciences to “collect data in naturalistic settings” by researchers who “observe and/or take part in the common and uncommon activities of the people being studied” (DeWalt and DeWalt, 2002, p.2). By taking notes and pictures of our experiences, and studying various internal and external documents such as the UNDAC Handbook (United Nations, 2006), we are able to provide an accurate account of the information management activities that took place. For this study we take a particular emphasis on the needs assessment process, but will also describe the information management processes that took place in general.

5.1.2 Observations

There were four important information management processes taking place in the exercise: (1) information gathering, (2) information sharing, (3) information presentation, and (4) information dissemination. Important information on the humanitarian response, such as which humanitarian organizations were working in the area, who would be the contact person of the organization, to which cluster would they belong, and who should be the cluster lead, was gathered and registered in the OSOCC. Whenever humanitarian organizations would have information that was relevant to the OSOCC, they would be able to visit or contact the OSOCC through telephone and e-mail. One UNDAC staff member was in charge of gathering and documenting information from all possible sources, such as media, e-mail, internally shared information, information from humanitarian organizations, information from local authorities, information from the clusters, and information from the

²Bartel Van de Walle and Willem Muhren

Humanitarian Coordinator, who is the senior-most UN official in a country experiencing a humanitarian crisis. However, the most important input of information for the OSOCC was the needs assessment process, which will be described further on. The OSOCC had a special communications room where people were constantly monitoring the radio traffic on the designated channels, in particular when assessment teams went out to conduct an assessment.

All gathered information was internally shared between UNDAC staff through Microsoft Groove. Microsoft Groove provides a platform with virtual workspaces through which groups of people can collaborate both online and offline, enabling UNDAC members to work jointly on the same documents, create, share, and store information in workspaces, and communicate both synchronously and asynchronously. The designated information gatherer was continuously documenting the incoming information in Groove, scanning Groove for any updates in the folders, and making sure that the right people would receive the information (which would mostly be the UNDAC staff in charge of the operations). Besides this internal information sharing, UNDAC chaired general coordination meetings on a regular basis in which information was shared with the larger international community. Usually UNDAC would organize a meeting every morning and every evening with delegates from all international humanitarian organizations. In these meetings the actual situation was discussed, and a plan of action was made on how to continue the relief. UNDAC also facilitated meetings with the cluster leads.

There were several ways in which UNDAC presented available information to visitors and to their own team members in order to facilitate the making sense of the situation. The OSOCC maintained a log book in Groove of all telephone and radio messages received or sent with action taken, which was updated by anyone who received or sent a message. UNDAC displayed information maps on a wall of the OSOCC which showed the area of the floods. Different types of information were indicated with post-it notes on the map displaying the most actual situation, such as the location of the assessment teams, key logistics features such as airfields and/or railway stations, and the security incidents in the area. The contact details were published next to the information maps, showing the phone numbers of people from the local authorities, UNDAC staff, team leaders from all humanitarian organizations, and the cluster leads. There was a screen projected on the wall with a display of the email inbox, so that all UNDAC staff could notice incoming emails. A so-called “pigeon hole” was created, where hardcopies of the assessments, minutes of meetings, and all other incoming information were stored at a central location. UNDAC maintained a directory with a data sheet on each humanitarian agency, indicating their contact points and areas of operation. A notice board was placed just outside the OSOCC, on which humanitarian organizations could leave notices regarding relief operations and coordination meetings, and on which UNDAC could display key information relevant to all humanitarian organizations, such as a general meeting schedule and contact information of the cluster leads. Finally, UNDAC made sure that stakeholders could get hardcopies of the information available in the OSOCC, such as situation reports and contact lists.

UNDAC would disseminate information through so-called “situation reports”, which described a short overview of the current situation, the assessments that had been conducted,

and the response that had been initiated. These situation reports were then distributed through Virtual OSOCC³, a web-based information platform on which crisis information is exchanged by relief actors working in all parts of the world, to the international community, which needed this information to make decisions on providing humanitarian assistance. One of the information managers in the OSOCC was continuously disseminating information through VOSOCC and scanning it for relevant information, such as relief planned by various international humanitarian organizations.

The most important input of information for the OSOCC was the needs assessment process. As we base our experimental study on this process, we provide a detailed description of how this worked in practice below.

The UNDAC staff did not conduct assessments themselves, but coordinated the joint needs assessments that were conducted by NGOs, UN agencies, and other international responders. The focus in the exercise was on rapid initial assessments, which should help determine the extent of a crisis and its impact on the population as well as needs for international assistance during the immediate relief phase.

During the exercise usually five teams would go out to conduct an assessment each day, to different locations, and each team would comprise around five people from different humanitarian organizations. Teams would be equipped with fixed radio in their cars and standard assessment forms for each individual. Radios were mostly just used for security reasons; teams had to report their location at different time stamps, and could use the radio in case of an emergency. The assessment forms were structured according to seven different themes of information that had to be assessed at each location: “demographics”, “health”, “water, sanitation, and hygiene”, “food and nutrition”, “shelter and non-food items”, “protection”, and “logistics”. Most of the teams assigned team members to one or two of these specific themes. The different team members would prepare themselves for the assessment by thoroughly reading through the questions in the relevant templates. When arriving at the crisis area, the assessment was mostly conducted by small groups of people, but each team member made sure that the team gathered information on their assigned sectors.

The rapid initial assessments were conducted through observation and semi-structured interviews. Observation gives a “feel” for the situation through sounds, smells, and visual impressions. More specific information was obtained by interviewing survivors, representatives of the survivors, and key officials, and that information was cross-checked with observations. In this information gathering phase, the assessment teams would not consult the assessment forms but would ask for information with the questions in the back of their head while making notes on a notepad. After the information gathering phase – in the car and back at the camp site – the teams would discuss the situation, what they had observed and heard, and would fill in the assessment form stating the outcome of their discussion. UNDAC staff debriefed the assessment teams when they completed the form, and shared this vital information as quickly as possible with the other UNDAC members in the OSOCC.

³<http://ocha.unog.ch/virtualososcc/>

5.1.3 Discussion of observations from a Sensemaking support perspective

In Subsection 1.3.2 we discussed that the Sensemaking properties should become resources in order to support Sensemaking optimally in humanitarian crisis response teams. Based on our observations in the Triplex exercise and Weick's suggestions listed in Table 1.1, we reflect below on how IS can improve support for Sensemaking by needs assessment teams. We do so for each Sensemaking property.

Social context

Microsoft Groove supports conversation in the OSOCC, but conversation with assessment teams is not supported yet. If IS support real-time communication between the OSOCC and the assessment teams, the latter will be able to receive important feedback on the situation and what to do, as the UNDAC staff has an overview of the situation as a whole. This will improve the assessment process: teams receive the latest information on crisis sites, affected people and the relief process, can obtain hints on other nearby areas to assess, and can much faster give important assessment findings back to the OSOCC.

Identity construction

Assessment team members and UNDAC staff all have their own identity, as they are working for various different humanitarian organizations but are delegated to these teams when a crisis strikes. When they go out to a mission, and people from various humanitarian organizations form teams to conduct assessments, they change their identity. IS could support assessment team members and people who communicate with them in the OSOCC to feel part of the same team with the same shared mission. This can be achieved when the assessment team members and people in the OSOCC use the same system; in this way, the teams will have the same defined identity.

Retrospection

After conducting the assessment individually, team members sit together to review what they saw and come to a shared assessment. However, there is a time gap between the actual assessment and the discussion and writing down of the final result. IS could help in capturing accurately what they assess, so they can review it whenever they need it: when constructing the final assessment by the team, and for transferring the assessment to the OSOCC. IS can assist this process by enabling digital capturing of information (e.g., pictures, digital notes instead of pen-and-paper ones), which will secure a faster and more accurate process.

Cue extraction

IS can assist actors in focusing on cues by indicating which cues are important in a certain setting according to historical data. When assessment teams are able to review previous assessments, they have a point of reference and can compare it to their own situation. IS could enable the teams to indicate some key features of the crisis (such as type of crisis, climate characteristics, type of relief needed, etc.) to obtain best-practice advice on what to pay attention to in that type of situation. The same feature can be applied to the OSOCC. As UNDAC is now using Microsoft Groove in their missions, information from previous missions can be consulted. There is, however, no time to go through all documents of previous missions. Moreover, through an IS in which assessment teams and the OSOCC are connected, UNDAC staff can give on-the-spot advice on which cues to pay attention to as they have the overview of what is going on.

Ongoing

As assessment teams are literally “thrown into the middle of things and forced to act without the benefit of a stable sense of what is happening” (Weick, 2001), they could be supported in continuous updating of the situation in order to make their experience and actions seem ongoing rather than an interrupted series of events. Again, communication with the OSOCC is important in this since it enables assessment teams to be continuously updated on the situation in the crisis area, giving them a stable sense of what is going on.

Plausibility

The focus in the assessment process is currently too much on probability than on possibility. Assessment team members make observations at a crisis site and conduct interviews, then negotiate their points of view with each other, only after that – when the most accurate picture is crafted – to communicate an assessment with the OSOCC. IS could again stimulate reflection in earlier stages of the assessment process between OSOCC and assessment teams, in which the assessment team members report a plausible account of what is going on, and on which the OSOCC can give relevant feedback.

Enactment

IS could stimulate action as a means of gaining more understanding of the situation. As we have seen in the previous discussion, IS can support various types of actions in these processes. Examples of action taken by assessment teams are interaction on what is going on and exchange of plausible accounts. The UNDAC people working in the OSOCC act when they actively engage in the assessment process and share their interpretation of the situation.

5.2 Group Decision Making and Information Processing

In humanitarian crisis response, as in other decision making settings, group members share certain kinds of information but not other kinds. This unshared information may arise either by chance or by design (Stasser and Titus, 1987): delegating specific sectors to different group members in the needs assessment team results in unshared information by design, and the fact that group members use different sources of information and visit different places results in unshared information by chance.

A *hidden profile* task is a laboratory tool (Hollingshead, 1996) for investigating information processes in group decision making, in particular concerning situations of unshared information, and is therefore a good tool for us to study the support, effect, and impact of Sensemaking on information sharing and performance in humanitarian crisis response. A hidden profile exists when group members individually have possession of only a part of the information required to reach an optimal decision or solve a problem, so the group needs to pool and process this information to solve the problem or reach the optimal decision (Choo, 2007). Stasser and Titus (1985, 1987) make a distinction between information that before discussion is shared (common information) and unshared (unique information). Because the common information supports a suboptimal alternative, individuals in a group need to pool the unique information to obtain perfect information (cf. van den Herik et al., 2002) as a group and find the optimal alternative – the hidden profile.

In the following subsection (Subsection 5.2.1) we discuss hidden profile studies more in detail, specifically regarding information sharing. In Subsection 5.2.2 we argue for an inclusion of Sensemaking in hidden profile studies. In Subsection 5.2.3 we discuss group support systems as they relate to humanitarian needs assessment. Finally, in Subsection 5.2.4 we discuss information load as an important independent variable to take into account in a hidden profile study simulating humanitarian crisis response.

5.2.1 Information sharing

Groups have the potential to make better decisions than any individual in the group, because groups have the ability to pool the available information held by all individuals. However, (hidden profile) studies have revealed that groups consistently fail to pool their available information, achieving distinctly suboptimal decisions (Dennis, 1996; Little et al., 2009; Stasser and Titus, 2003; Rutkowski et al., 2006). Stasser and Titus (1985), the founders of hidden profile tasks, discovered that groups tend to exchange, discuss, and use information that is known to all the members at the expense of information that is known to a single member when jointly making a decision. Common information will also be brought up more repeatedly during discussion (Stasser and Stewart, 1992). Early experimental results (e.g., Stasser and Titus, 1987) reveal that much of the discussion is

devoted to reiterating already-exchanged information.

The first bias that causes the large focus on shared information in group decision making is the informational bias, which emerges because individual group members are given partial sets of information that do not reflect the balance of available supporting arguments for the various decision alternatives in hidden profile studies (Stasser and Titus, 1985). The second bias is the preference bias, meaning that individuals are biased in their preferences as they prefer alternatives at the onset of discussion that they would not prefer if they had complete information (Stasser and Titus, 1985). These two biases lead to a bias in the content of the discussion, which tends to reflect but not correct biases introduced by the distribution of information over group members before discussion, resulting in unequal discussion of common information as opposed to the group members' unique information (Stasser and Titus, 1985).

Other reasons for the focus on shared information besides the previously mentioned biases are that an item of information is more likely to enter discussion if it is shared rather than unshared and if it favors rather than opposes the existent preferences of group members. Group discussion is often thematic and consensus confirming, as it tends to focus on supporting an existing or emerging consensus, and group members will actively advocate their preferred alternative during debate (Stasser and Titus, 1985).

In order to make use of the group advantage and make better informed decisions than any individual would be able to make, groups need to pool their unique information. The focus in groups has to be redirected from common information discussion to unique information discussion. Effective pooling of unique information involves three dimensions of discussion: unique information has to be (1) mentioned, (2) reconsidered, and (3) focused on (Stasser and Stewart, 1992). Mentioning of unique information in itself is not sufficient, as previous studies have indicated that the group's attention tends to redirect swiftly to the common information. Unique information has to be repeated and form a significant proportion of the group's discussion.

5.2.2 Sensemaking

Stasser (1988) found that even if group members do not advocate their preference and are unbiased in their contribution of information, they would fail to discover the hidden profile. Stasser and Birchmeier (2003) interestingly note that group decision making is inherently a convergent process and seems to be the antithesis of group creativity. The information sharing construct embodies this convergent behavior, for which members share different pieces of information and narrow down the decision alternatives to reach a best decision. But there is more to good performance – managing and responding to a crisis, finding the hidden profile – than effective information sharing per se. What is needed is a construct which embodies the more cognitive, information processing and creative behavior of groups. To take the example of humanitarian crisis response teams: The sharing of information is not the only characteristic of their group decision making process which influences performance. More information sharing is important, but it is also important how they cope with interruptions, and how they create and maintain an infrastructure for

their Sensemaking communication activities of noticing what is going on in the environment, updating their understanding of the situation, more specific inquiring, triangulating information and negotiate on what is going on, verifying information, reflecting with team members, and enacting to gain understanding of their situation (see Chapter 3).

We believe that the group's Sensemaking attainment is an important mediating factor. In this chapter we investigate whether and how Sensemaking plays a role. We focus on social Sensemaking, ongoing Sensemaking, and Sensemaking outcomes, as these are previously argued to be of most significant importance in group Sensemaking in humanitarian crisis response (see Section 4.1).

5.2.3 Group support systems

Our observations of the needs assessment process suggest that the current communication process – radio communication while assessing the needs and subsequently face-to-face group discussion to establish a single assessment which is handed over to UNDAC – has potential to be improved. Previous hidden profile studies (Stasser and Titus, 1985, 1987; Stasser, 1992) also seem to suggest that face-to-face discussion seems poorly suited to discovering hidden profiles. As Stasser puts it, “face-to-face discussions are not social systems that facilitate the airing of unshared information” (Stasser, 1999).

Group Support Systems (GSS) provide groups with several benefits over face-to-face collaboration, such as the ability to communicate in parallel with each other, the removal of barriers to communication, increasing equality of participation, the possibility of storing all contributed information in an automated, digital group memory, and tools and structures to coordinate group processes, thereby increasing the quality of decision making (Turoff et al., 1993; Shirani, 2006). Moreover, GSS can enable a collaborative learning environment that facilitates the acquisition of knowledge (Muhren et al., 2009). GSS not only offer benefits to group decision making. Nunamaker et al. (1991)'s distinction between process gains and process losses of group work using GSS makes it possible to more specifically identify the pros and cons of GSS usage. There has been a substantial number of hidden profile studies in which face-to-face groups were compared to GSS supported groups, such as by Dennis (1996), Hollingshead (1996), Shirani (2006), and Kerr and Murthy (2009). There seem to be large differences in the results of these studies. In some instances, computer-mediated groups tend to suppress information compared to face-to-face groups, make fewer comments, are unable to process information effectively due to lack of immediate feedback, and take longer to reach decisions (Hollingshead, 1996; Kerr and Murthy, 2009). When in other studies groups supported by GSS share more information (Dennis, 1996; Shirani, 2006), the unique information was often not exploited in the decision making process and consequently the probability of discovering the hidden profile did not tend to increase.

In the reality of humanitarian crisis response teams as we have observed, it takes a lot of time and traveling effort to reach a decision: First every individual team member has to go out with pen and paper to make an assessment while using basic radio equipment, they have to convene together to compare and discuss their findings and finally travel to the OSOCC to debrief UNDAC team members in person. To have assessment teams

communicate with support of more advanced GSS (e.g., handheld PDAs) would first and foremost increase time efficiency: They would reach a group decision faster as they would be better able to communicate when they are physically separated and would not have to travel to gather face-to-face, and the OSOCC would be sooner informed of the group assessments resulting in a quicker response of the international humanitarian community to the crisis affected population. We therefore will compare both these GSS settings to each other in our research: The “traditional GSS setting” characterized by radio communication followed by face-to-face communication, and the “new GSS setting” characterized by text-based communication, both represented in Figure 5.1.

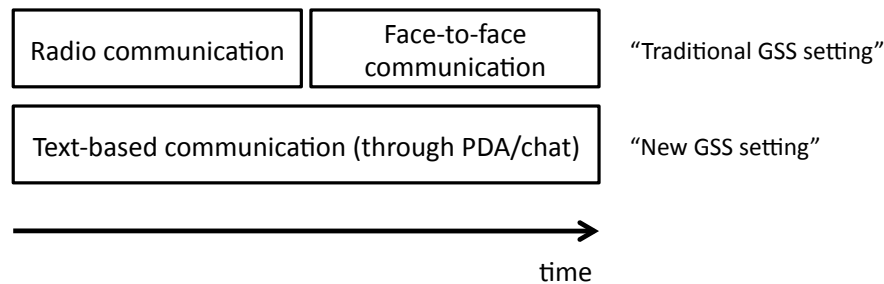


Figure 5.1: The two GSS settings that are studied

We are obviously interested in whether the effectiveness of the group decision making process can be increased with GSS. But more advanced GSS support would already significantly impact humanitarian assistance in terms of time efficiency if it would not “harm” the decision making process, i.e. if the use of GSS would not lead to a decrease in group decision making effectiveness.

5.2.4 Information load

Decision tasks may differ in the amount of information available to decision makers (Stasser and Titus, 1987). Intuitively, it seems rather obvious that the more information groups have at their disposal, the more informed and thus the better their decisions will be. This however is not necessarily the case, and would almost be argued for the contrary, as too much information causes situations of information overload. Information overload (Hiltz and Turoff, 1985; Rutkowski and Saunders, 2010) is a state in which information processing capabilities and the information loads encountered are mismatched (Sutcliffe and Weick, 2008). The load of information which responders are exposed to and are able to deal with plays an important role in crisis response (Van de Walle and Turoff, 2008; Turoff and Hiltz, 2009). Information overload causes groups to restrict their information processing and is very harmful to reliable crisis response (Turoff et al., 2004).

The problem in situations in which people are struggling to make sense, situations of ambiguity and equivocality (see Chapter 2), “is not that the world is imperfectly understood and that more information will remedy that. The problem is that information may

not resolve misunderstandings” (Weick, 1995, p.92). Klein et al. (2006) even call it a myth that more information leads to better Sensemaking. Sensemaking skills however can make the seemingly inexplicable and irrelevant load more relevant (Sutcliffe and Weick, 2008). “The meaning of a particular piece of data depends on what else is going on, what else could be going on, what has gone on, and [what] the observer expects or intends to happen” (Woods et al., 2002). When people create a better understanding of the situation, they are able to link more of the cues with their frame of reference, and less pieces of information are considered to overload them. Higher Sensemaking attainment should therefore facilitate the management of excess information load and lead to higher performance, but this does not necessarily depend on the information load itself.

In humanitarian crisis response teams, high information load could cause problems of information sharing and information processing. Although we do not expect information load to influence Sensemaking, it is – as previously discussed – of high practical relevance to take the load of information that groups are exposed to into account for our study, and examine its influence on information sharing and performance. Stasser and Titus (1987) and Stasser (1992) have studied the effect of lower and higher information loads before in hidden profile studies, and found evidence suggesting that groups may disseminate information more effectively when decision tasks involve relatively little information.

5.3 Research Model and Hypotheses

Stasser and Titus (1985, 1987) and later other researchers (e.g., Lightle et al., 2009) focused very much on the effect of different experimental conditions on outcome variables, especially on information recall which does not play a role in our experiment, and not on process variables which measure the information that was shared. Nearly all other hidden profile studies that do include process constructs in the research model, such as Mennecke (1997), only use information sharing to explain the effect of the experimental condition(s) on performance. We argue that the group’s Sensemaking attainment is, besides information sharing, another important mediating construct to determine the performance of humanitarian crisis response teams. In this study we will test the effect of the different humanitarian response settings (determined by the group support and information load) which teams are confronted with on information sharing (the amount of information exchange in general and the focus on unique information in particular) and Sensemaking and subsequently performance. The conceptual research model with hypothesized relationships between the different constructs is presented in Figure 5.2.

In the next subsections we formulate hypotheses on the influences of GSS setting (Subsection 5.3.1), information load (Subsection 5.3.2), information sharing (Subsection 5.3.3), and Sensemaking (Subsection 5.3.4) on the other constructs based on the hypothesized relationships indicated in Figure 5.2.

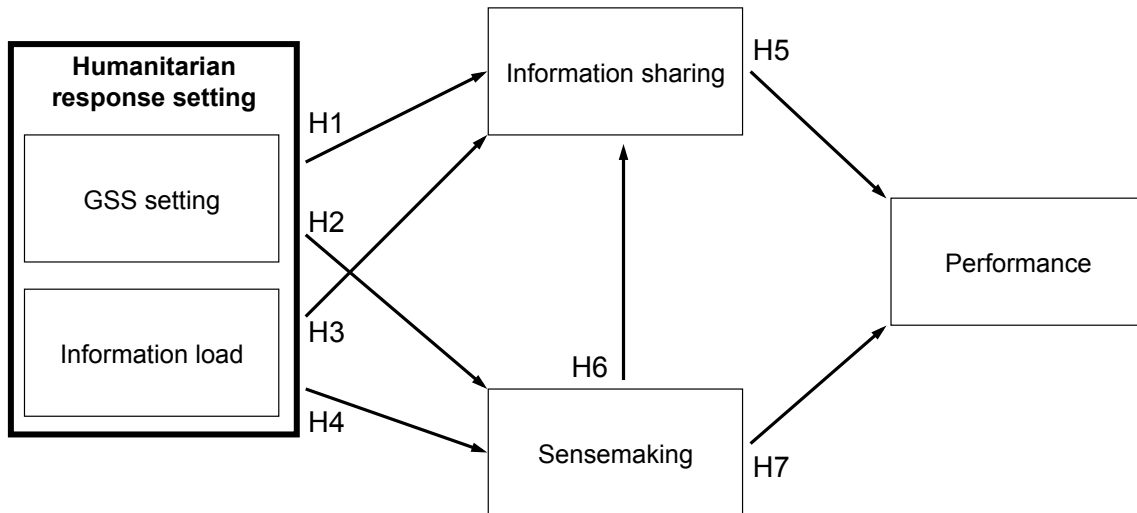


Figure 5.2: Conceptual research model

5.3.1 GSS setting

Although face-to-face group decision making settings are not suited for optimal (unique) information sharing, GSS studies do not provide conclusive evidence for improvement. Our goal is to study whether a change in support of the group decision making process will at least be as good as the current communication and decision making procedures. The difference of our study to traditional hidden profile studies, in which GSS supported groups are compared to face-to-face groups, is that we include radio communication in the communication process of the latter (see Figure 5.1) as this reflects the reality of humanitarian crisis response teams.

Information pooling is a cognitively demanding process, and therefore groups must be given the resources to make it feasible (Stasser and Birchmeier, 2003). In particular, the GSS components of parallelism and group memory (Nunamaker et al., 1991) are said to affect information sharing (Dennis, 1996) and are relevant to our study. Parallelism, the ability of participants to communicate and enter information simultaneously and in parallel (Nunamaker et al., 1991), mitigates blocking caused by participants having to wait for others to finish before contributing information (Dennis, 1996). Parallelism may also encourage exchange of different information because more themes emerge and broader discussion of key issues takes place (Dennis, 1996). Parallelism therefore seems to support the group's exchange of information. This is in contrast to what other researchers have found, who conclude that individuals tend to suppress information when using GSS (Hollingshead, 1996) and exchange less information than face-to-face groups (Hollingshead, 1996; Kerr and Murthy, 2009).

We think that this contradiction can be explained by the type of GSS that is used, and more in particular whether GSS supports structured discussions. In Dennis (1996)'

study, groups were using a GSS in which they could enter their comments in boxes that were prestructured according to the different topics that could be discussed. This makes parallel discussion very efficient, as topics are grouped together and it is immediately clear to what the newly inputted information relates to. In other words, there is no disadvantage to team members contributing different types of information at the same time. On the other hand, Hollingshead (1996) and Kerr and Murthy (2009) use unstructured GSS such as a common message board.

In our case we want to test the effect of newly-introduced GSS support, handheld text-based communication devices. If team members contribute different types of information at the same time in a text-based group discussion on a PDA, all information is listed one after the other, and there is no structure in the discussion. Parallelism therefore has a very marginal effect on the group discussion, as team members will discuss one topic at a time. The rehearsability (Dennis et al., 2008) of the communicating medium, on the other hand, is expected to have a much stronger effect on the information exchanges, as it will take more time for people to type and carefully craft a message than to verbally communicate the same information.

Hypothesis 1a. *Teams supported by simple text-based GSS exchange relatively less information than teams discussing through radio and face-to-face.*

Because GSS can store the information that is exchanged, group memory is created, enabling participants to review and refer to previous information exchanges later in the discussion (Dennis, 1996). Moreover, a group memory enables participants to enter or read information at their discretion, unlike in verbal communication where one has to listen to the discussion and process information at the same time (Dennis, 1996). Group memory may also reduce the need for social validation and enhance the acceptance and consideration of unique information (Stasser and Birchmeier, 2003). Group memory therefore seems to support the group's focus on unique information. However, the unstructured nature of our GSS support is expected to restrain this. Because in this unstructured GSS discussion team members will have to scroll back and search for information that has already been contributed previously, group memory is expected to have a marginal advantage and will in practice most probably not lead to an increase in consideration of unique information.

Hypothesis 1b. *There is no difference between teams supported by simple text-based GSS and teams discussing through radio and face-to-face in their focus on unique information in discussions.*

As previously discussed on in Section 4.1, we focus in our group Sensemaking in humanitarian crisis response research on the social Sensemaking and ongoing Sensemaking properties. First we will discuss the hypothesized impact of the GSS setting on *social Sensemaking*. Recall that we previously (see Chapter 3) identified five different communication activities that actors use in crisis situations which characterize their social Sensemaking, interacting behavior. Four of these Sensemaking communication activities – triangulating, inquiring, verifying, and reflecting – seem of high importance in this particular group Sensemaking

setting; the fifth activity – updating – is more concerned with building and maintaining a network of contacts in a crisis setting and seems of minor importance to our current study. In Chapter 3 we used MST (Dennis et al., 2008)’s media characteristics to identify the media capability needs for these four types of interacting behavior. As presented in Table 3.3, for triangulating, Sensemakers appeared to be best supported by high transmission velocity, few symbol sets, and high parallelism, while for inquiring, verifying, and reflecting, Sensemakers would be best supported by high transmission velocity, few symbol sets, and low parallelism.

In our experimental setup we contrast the traditional GSS setting of radio and face-to-face communication with the “new” GSS setting of simple text-based communication. When comparing these settings to MST’s media characteristics, we observe that radio communication can be characterized as having few symbol sets, high transmission velocity, and low parallelism; face-to-face communication can be characterized as having medium symbol sets, high transmission velocity, and medium parallelism; and text-based GSS communication can be characterized as having few symbol sets, medium transmission velocity, and medium-high parallelism. This would imply that our new GSS condition would be better suited for Sensemaking’s triangulating activity due to the higher parallelism, while radio communication and face-to-face communication would be better suited for Sensemaking’s inquiring, verifying, and reflecting due to its higher transmission velocity and lower parallelism. Thus, when considering social Sensemaking, there is no clear advantage of either GSS setting.

Second, we want to investigate the impact of the GSS setting on *ongoing Sensemaking*. Ongoing Sensemaking implies the importance of having a smooth and continuous communication process, in which the team can communicate without interruptions or can recover swiftly from occurring interruptions (see Chapter 4). We experienced at Triplex (see Section 5.1) that radio communication is an unreliable means of communication (Van Den Eede et al., 2008a), through which it is very often difficult to understand what other people are saying and which does not lead to a smooth communication process. We therefore hypothesize that this communication medium has a negative effect on the team’s Sensemaking. On the contrary, text-based GSS support enables teams to continuously type and share their information inputs without interruptions.

This leads to the following hypothesis.

Hypothesis 2. *Teams supported by simple text-based GSS attain higher Sensemaking than teams discussing through radio and face-to-face.*

5.3.2 Information load

In a condition of low information load proportionally more of the information is expected to be discussed than in a high information load condition (Stasser and Titus, 1987).

Hypothesis 3a. *Teams exposed to lower information loads exchange relatively more information than teams exposed to higher information loads.*

High information load affects “what is bracketed as being in need of deciding” (Sutcliffe and Weick, 2008). Information overload can lead to less systematic and less thorough information search and retrieval, and “a general lack of perspective, an inability to select out relevant information, and increasing ‘distraction by irrelevant and interfering cues’” (Sutcliffe and Weick, 2008). These are indications that groups exposed to higher information loads will be less able to identify the importance of unique information and consecutively will spend relatively less time on discussing unique information than groups exposed to lower information loads.

Hypothesis 3b. *Teams exposed to higher information loads focus relatively less on unique information in their discussions than teams exposed to lower information loads.*

The suggestion by Weick (1995, p.92) and Klein et al. (2006) that more information does not necessarily lead to better Sensemaking is very interesting and never examined before. We will therefore test whether we can reject the following hypothesis:

Hypothesis 4. *Teams exposed to higher information loads attain higher Sensemaking than teams exposed to lower information loads.*

5.3.3 Information sharing

From our literature study we did not find any indications that information sharing has an effect on Sensemaking.

The more information groups are aware of, the better their decision will be (Mennecke, 1997). More information exchange leads to more informed group decisions than group members could make individually (Stasser and Titus, 1985). It also has a corrective function: groups are able to reach an unbiased, complete picture of the decision alternatives (Stasser and Titus, 1985). Discussing and identifying different types of information, both common and unique, will lead to a higher consensus in groups.

Hypothesis 5a. *Teams that exchange relatively more information perform better than teams that exchange relatively less information.*

“The information that members bring to the group plus the information that they gain through discussion are important factors in shaping their individual preferences and their collective decision” (Stasser and Titus, 1987). Research has shown that a common information item is more likely to be discussed than a unique item (Stasser and Titus, 1987). The discussion of unique information should be particularly persuasive in the context of group discussions, as it has the potential to change a preference or modify the strength of a preference. As unique information is biased towards the best decision, i.e. the hidden profile, and more sharing of this information would lead to a change of preference in favor of the hidden profile, this leads to the following hypothesis:

Hypothesis 5b. *Teams that focus relatively more on unique information in their discussions perform better than teams that focus relatively less on unique information in their discussions.*

5.3.4 Sensemaking

From literature review we did not find any indications that Sensemaking influences the *amount* of information being discussed, but Sensemaking could influence the *type* of information that is discussed. Groups with more diversity contribute more differing information and points of view to a group discussion (Stasser and Titus, 1987). This highlights the importance of (social) Sensemaking: groups that make more use of their social Sensemaking resources should contribute more differing information and points of view to a group discussion. In practice that means that a higher requisite variety (Ashby, 1956) will lead to groups having more unique information to base their decision on. In our hidden profile study, it means that teams using more social Sensemaking resources will manage to identify and use more unique information. And teams that are better able to cope with interruptions, who attain higher ongoing Sensemaking, will only be strengthened to keep their focus on unique information.

Hypothesis 6. *Teams that attain higher Sensemaking focus relatively more on unique information than teams that attain lower Sensemaking.*

“Sensemaking that is focused on interpretation and meaning mitigates overload” (Sutcliffe and Weick, 2008). From our interpretive information processing perspective on Sensemaking, teams that attain higher levels of Sensemaking, such as through making more use of their social Sensemaking resources and being resilient to cope with interruptions, will be able to better cope with overload, be able to better ascribe meaning to what is happening, and hence perform better.

Hypothesis 7. *Teams that attain higher Sensemaking perform better than teams that attain lower Sensemaking.*

5.4 Research Methodology

We conducted an experimental hidden profile study to test the hypotheses and the overall research model, previously presented in Figure 5.2. In Subsection 5.4.1 we present more information on the participants of our hidden profile study. In Subsection 5.4.2 we present the task they were given. In Subsection 5.4.3 we outline the procedures of the experiment. In Subsection 5.4.4 we discuss the two different treatments in the experiment: GSS setting and information load. Finally, in Subsection 5.4.5 we discuss the different variables we defined to measure the constructs from our research model (Figure 5.2).

5.4.1 Participants

One hundred forty four undergraduate and graduate students took part in the experimental sessions in spring 2010 at Tilburg University. Almost half of the participants were Chinese (68 students), approximately twenty percent were Dutch (29 students), and other participants came from Indonesia (7 students), Turkey (6 students), Germany (4 students),

Vietnam (4 students), Bulgaria (4 students), Poland (3 students), Lithuania (2 students), and single representatives from various other countries across the world. The average age of the participants was 23 years, and 51% were female. The participants were randomly assigned to a three-person team, for a total of 48 teams in the study.

5.4.2 Task

Hidden profile studies have hardly ever been applied to crisis management (Mentis et al., 2009, as a notable exception). As there has not been a hidden profile study before on group decision making in humanitarian assistance, we developed the case and hidden profile outline ourselves. The task was based on a floods scenario, developed by UN OCHA for exercise purposes, and was complemented with the authors' insights and experiences gained at the Triplex exercise and other exercises, humanitarian workshops, and case studies (discussed in the previous chapters).

Following heavy rains in the fictive country of Juliandia, severe flooding severely affected three districts, all bordering the neighboring country of Emirana: Norktown District, Grotti District, and Petersted District. The students were told to be part of three-person UNDAC teams that were deployed to the affected districts to conduct rapid initial assessments. The role of the team was to advise the UN Humanitarian Coordinator to which district the international humanitarian organizations need to deploy first.

The team members had to imagine to be traveling through the area separately to conduct assessments by observing the impact of the crisis and interviewing survivors, school teachers, priests, and key officials. In reality, each student was seated in a separate cubicle, and was presented a set of information elements which he or she gathered on his or her imaginary assessment trip on different sectors of humanitarian assistance: "health", "water, sanitation, and hygiene", "food and nutrition", "shelter and non-food items", "logistics, access, and security", and depending on the information load condition, "protection". Although it was not explicitly mentioned, students were given two types of information for each of the three affected districts: positive information and negative information. Positive information indicated that humanitarian assistance was needed for the specific sector of humanitarian assistance; negative information indicated that humanitarian assistance was not needed for a specific sector in the specified area.

The students were explicitly told that the international humanitarian community can respond to all the types of needs listed under the sectors of their assessment sheet, and that they could consider all sectors to be of equal importance to each other for this exercise. For example, a need in "health" was said to have the same importance of humanitarian response as a need in "logistics access and security". The students were instructed to discuss the situation according to their assessment results with the other team members and to give the Humanitarian Coordinator an advice on the order of priority of the three districts for international humanitarian assistance.

Hidden profile outline

Unlike in other hidden profile experiments, we made sure that positive and negative items would cross out each other in order to facilitate the ease for participants to make an assessment of the humanitarian situation. In traditional hidden profile experiments, participants would for example receive positive and negative information items for student body president candidates, and the hidden profile would be the candidate who had in total more positive aspects than negative aspects. This would be very confusing for our participants, as they are no experts in humanitarian assistance. We therefore did not ask them to make judgments of what type of assistance (e.g., food or medical care) is more important in that particular situation. In their case, they could cross out positive and negative information items. There would be for instance a positive information item indicating that children were feeling cold at night in that district, and a matching negative item indicating that a relief agency was already sending blankets to the affected population in that area. If all positive and negative items would be crossed out against each other, there would be a few unmatched negative items for the wrong solutions (extra humanitarian assistance than deemed necessary) and a few unmatched positive items for the hidden profile (needs of the affected population that were not addressed yet).

The distribution of the different information items is presented in Appendix G. There were two different versions of the task: One version with fewer information items (low information load) and a second version with more information items (high information load). All team members within the same treatment had an equal mix of common information (known to all team members) and unique information (known to only one team member). Information elements were on average 32 words each. In total, there was 50% more positive (information items in Appendix G with a “+” sign) than negative (information items in Appendix G with a “-” sign) information for the hidden profile solution, and 50% more negative than positive information for the other two districts. If therefore all information is put together, it was obvious that the two “wrong” districts (in Appendix G, the districts with information items of type A and B) received more humanitarian assistance than was assessed to be needed, and that the hidden profile district (in Appendix G, the district with information items of type C) needed more humanitarian assistance than was assessed to be provided and was therefore the best district to advise the humanitarian coordinator to first direct resources towards. In accordance with Stasser and Titus (1985), we use the term *best* in a very restricted way. The best alternative is the alternative that is supported by the preponderance of the information that is collectively available to the group, and is not necessarily the correct alternative. Because we developed the hidden profile task ourselves, and it is a judgmental rather than intellectual decision task (Stasser and Titus, 1985), it needs to be validated. We asked four humanitarian crisis response experts⁴ to validate the case. When considering all information items together, all four experts chose the hidden profile as the worst affected district which needs assistance most urgently⁵,

⁴Humanitarian crisis response officers working for UN OCHA, UNDAC/B-FAST, Belgian government, and NATO.

⁵Although in real-life such prioritization is not that black and white and interventions related to the

confirming that our designed hidden profile is indeed the “best” group decision to make.

Difference to traditional hidden profile studies

In our experiment we did not ask the teams to “pick one right alternative”, which is commonly done in hidden profile studies (e.g., identify the murderer, the “best” candidate for president), because in humanitarian assistance – as in many other situations – it is very difficult to say that there is one right course of action. Instead, we ask the teams to rank-order (prioritize) the alternatives (cf. Hollingshead, 1996; Mennecke, 1997). This is more in line with reality, as a decision to send scarce humanitarian relief to the alternative that is supported by the least amount of arguments is not a bad decision, but one of less priority. On the other hand, identifying an innocent person as the murderer is obviously a bad decision.

In most hidden profile studies, participants have to hand in the information elements after they have read them. In our experiment the participants had perfect recall (Hollingshead, 1996): we did not ask the teams to hand in the information elements before they started the group discussion, but allowed them to keep the information elements. This is more in line with real-life humanitarian assistance, as they write down what they observe and are able to review their notes when they discuss with their team members or OSOCC, and it is unlikely that assessment team members will lose information they collected. Our perfect recall study results in less of a preferential bias than experienced in most traditional hidden profile studies. Information sampling is biased by the member’s current preference, and because in traditional hidden profile studies the members cannot look back at their information items, they will mostly recall only the items of the alternative which they preferred (e.g., Stasser and Titus, 1985). Since we feared that the teams would find the hidden profile easily since they had perfect recall, as happened in one of the few other perfect recall hidden profile studies (Lightle et al., 2009), we increased the number of information elements compared to traditional hidden profile studies, even in the “low information load” condition.

Pilot studies

The task was pilot-tested twice: (1) with a group of 48 undergraduate students in fall 2009, and (2) in spring 2010 with a group of 18 undergraduate and graduate students.

In the first pilot experiment, as reported on previously (Muhren et al., 2010b,a), students of the course “Decision Support Systems” at Tilburg University were participating, and they had to write an individual assignment based on their experiences in the experiment. We used a similar experimental setup and a similar case, although the district that

different sectors are different, as one expert further clarified. First of all you have to prioritize life-saving activities, then life-sustaining and preventive activities, followed by early recovery issues. Recently, such as in response to the 2010 Pakistan earthquake, the international humanitarian community has started using an indicator-based ranking system of disaster-stricken areas.

was the hidden profile solution in this experiment was excluded from the final case. Notably, none of the sixteen teams managed to uncover the hidden profile solution in this first pilot. We however observed a difference in information sharing and Sensemaking between the different treatment conditions.

Because all three individual members of a team were heavily biased against the hidden profile, almost everybody discarded this district before the group discussion started, and continued to almost only discuss the two suboptimal districts. The bias that the distribution of information caused appeared to be too big to overcome. We believe that in this way, the experiment was not representative for a real humanitarian crisis situation. Based on their relevant experience, professional humanitarian crisis responders would not a-priori discard an area for humanitarian response.

Our pilot experiment highlighted the importance of conflict in group decision making, as noted before by, e.g., Janis (1972) and Fisher (1980): a lack of initial consensus avoids discussion that uniformly supports one alternative and promotes more extensive and exhaustive sampling of the total available information (Stasser and Titus, 1985). When there is initial consensus, groupthink (Janis, 1972) may cause novel information to be perceived as threatening when members sense that they are progressing toward a mutually valued goal and the novel information may impede this progress (Stasser, 1999). Consensus implies correctness (Stasser and Birchmeier, 2003). In our pilot experiment without conflict there was often not even much discussion before reaching agreement on the “wrong” decision.

Following the example of Dennis (1996), we therefore created a majority/minority situation in our final experiment, but we did not have interest in examining the effects of minority influences per se. We adjusted our case to bias one team member in favor of the hidden profile, and two team members in favor of the same, suboptimal alternative district. In this way, the group can still make a better informed decision than each individual group member, and has the potential of being more accurate than the average of its members (Hollingshead, 1996), the so-called “assembly effect” (Stasser, 1992).

Before we conducted the final experiment, we once more conducted a pilot study with 18 undergraduate and graduate students. In this pilot we found that the bias we constructed for each individual team member was not strong enough, as only 28% of the individuals listed a preference for the district they were biased towards before discussion. Although it was only a small pilot group, this is not what we intended and considerably lower than the 74% obtained in a similar hidden profile study (Dennis, 1996). We had given each team member only one more positive than negative information item for the district they were biased towards. We redistributed the positive and negative information elements to increase the strength of each team member’s informational bias in the final experiment, which resulted in an acceptable rate of 85% of participants’ pre-discussion preferences intended by the information they received in the low information load condition, and 79% in the high information load condition.

5.4.3 Procedures

Enrollment for the experiments was open to all students of the university, but mostly attracted students of the school in economics and management as recruitment e-mails were sent out to approximately one thousand students who participated in economic experiments in the last few years and who indicated to be interested in participating in future experiments. Students enrolled to “participate in a group decision making experiment concerning a fictive disaster situation”, and were told that a good command of English would be essential.

The experimental procedures followed those of traditional hidden profile studies, such as by Stasser and Titus (1985) and Dennis (1996), unless specified otherwise in Subsection 5.4.2. Participants were randomly assigned to a team and were randomly assigned a role in their team, namely “Alpha”, “Bravo” or “Charlie”. They used this role name, which facilitated the ease of group communication and is a North Atlantic Treaty Organization (NATO) standard, throughout the experiment. Participants received a brief introduction to the case and a brief instruction on how to use their communication medium, depending on their GSS treatment, and could test it for a few minutes with their team members using their role name. After they took place in their own cubicles, without having the possibility of communicating with their team members, they received their case description. The case they received consisted of introductory text to the situation, the flood disaster that had happened, a description of the role that the person and his or her team had and what was expected, and the information elements (needs assessments conducted by him or her). In total this comprised three pages of text for individuals in the low information load condition and four pages for the high information load condition. All participants also received the same geographic map of the situation, developed by the humanitarian NGO MapAction⁶ for a humanitarian crisis response exercise. Participants got 20 minutes to read the case and take their own, personal notes. Next, they received a short on-screen survey asking them to list their pre-discussion preferences, after which group discussion commenced. After 20 minutes of group communication they were asked to list their personal preference again, before they could start with the last part of the group discussion. Teams got an additional maximum of 20 minutes in the second part to reach a final group decision. Thus, in total teams got 20 minutes to read the case and 40 minutes to discuss their findings in the group. When a group decision was agreed upon, participants received a final and longer post-session individual survey which they had to fill out – without having the possibility of discussing with their team members – before the experiment finished. All surveys and GSS tools were programmed with z-Tree, which is commonly used software for experimental economics. Because we programmed all survey items as required fields in z-Tree, we did not have any missing data.

Students received €7.50 for participating. Our concern, especially after the pilot experiment which, similar to Stasser and Titus (2003), demonstrated little discussion of all alternatives, was that students would not take the task seriously and that our results may not generalize to other populations and group tasks. We therefore announced to raffle

⁶<http://www.mapaction.org/>

3 iPod shuffle (4GB) players among the best performing students. This was foremost to stimulate the students to do their best effort in the experiments. We preferred such a raffle to a higher monetary reward for higher performance, which is commonly done in experimental economics. In this way we would only have to reveal how we defined performance and which teams performed best after all the experimental sessions had finished, and would not have to compromise the hidden profile solution. After reading the case, but before group discussion had started, participants indicated on a 5-points Likert scale from 0 (strongly agree) to 4 (strongly disagree) on average 0.979 ($SD = 0.957$) that “This case seems interesting to me”, and on average 1.201 ($SD = 1.150$) that “I am motivated to do my best to win an iPod”, both indicating that on average the participants were very eager to participate in the experiment and do their best effort.

5.4.4 Treatments

The teams were randomly assigned to a treatment condition regarding the GSS setting and information load. Both treatments simulate possible humanitarian response settings of needs assessment teams, and are summarized in Table 5.1.

Table 5.1: The two treatments simulating four possible humanitarian response settings

			GSS setting	
			Traditional	New
			Radio communication followed by face-to-face	Text-based communication
Information load	low	45 information elements total	<i>12 teams x 3 subjects</i>	<i>12 teams x 3 subjects</i>
	high	75 information elements total	<i>12 teams x 3 subjects</i>	<i>12 teams x 3 subjects</i>

GSS setting

We wanted to compare the current procedure of group communication during needs assessments, in which teams communicate by radio with each other and then convene face-to-face to continue the discussion and reach a group decision, with a possible alternative. We provided half of the participating teams with simple GSS support, such as handheld text-based communication devices, so teams would not need to convene face-to-face. When simulating the first GSS setting, called the “traditional GSS setting” from now onwards, we gave each team member a handheld transceiver with which they could communicate the first 20 minutes. After this they met face-to-face to continue the group discussion and reach a final group decision.

In the “new GSS setting”, we simulated the team members’ use of handheld text-based communication devices with simple instant messaging software, programmed with z-Tree. The instant messaging (chat) interface was designed using three boxes: the small top part of the screen showed which role the individual had in the experiment and the remaining time for discussion, the main and largest part of the screen displayed the group discussion history, and participants could type in their message in the small, lower part of the screen.

At all times team members were able to consult their own instructions and information sheets, though it was not allowed to share their notes or physical information sheets with their team members during the face-to-face discussions; participants were explicitly instructed only to verbally discuss, but were allowed to make new group notes.

Information load

For the second treatment we simulated situations with lower and higher information loads. Appendix G shows the distribution of the information elements for both information load treatments. In the low information load condition, each team member received 15 common and 10 unique information elements, for a grand total of 45 different information elements. Alpha received three more positive than negative information items for a bias towards the hidden profile district, Grotti District, and slightly more negative than positive information items for the other two districts. Both Bravo and Charlie received three more positive than negative information items for the suboptimal, Norktown District, and received slightly more negative than positive information items for the other suboptimal district and the hidden profile solution.

In the high information load condition, each team member received 33 common and 14 unique information elements, for a grand total of 75 different information elements. Charlie received three more positive than negative information items for a bias towards the hidden profile district, Petersted District, and slightly more negative than positive information items for the other two districts. Both Alpha and Bravo received three more positive than negative information items for the suboptimal, Norktown District, and received slightly more negative than positive information items for the other suboptimal district and the hidden profile solution.

5.4.5 Measures

The measures in this study were collected at either the group or individual level, but in the latter case always aggregated to the group level. The variables we used to measure the underlying constructs from Figure 5.2 are presented in Table 5.2, and discussed below if they are not previously mentioned.

Information sharing

The group discussion in the radio and face-to-face setting was digitally recorded, and the group discussion history in the new GSS setting was automatically stored. This enabled us

Table 5.2: Variable definitions and measurement

Construct	Variable	Type	Variable description	Variable measurement
GSS setting	GSS setting	Nominal: dichotomous	GSS setting of the team, which was either traditional (radio communication followed by face-to-face discussion) or new (chat)	0 = traditional GSS setting 1 = new GSS setting
Information load	Information load	Nominal: dichotomous	Information load that the team was exposed to, which was low or high	0 = low information load 1 = high information load
Information sharing	Fraction of total items exchanged	Ratio: continuous	Different information items that were exchanged relative to the total number of information items received before discussion	different items exchanged / total number of items available
	Fraction of common items exchanged	Ratio: continuous	Different common information items exchanged relative to the total number of common information items received before discussion	different common items exchanged / number of common items available
	Fraction of unique items exchanged	Ratio: continuous	Different unique information items exchanged relative to the total number of unique information items received before discussion	different unique items exchanged / number of unique items available
	Unique item discussion ratio	Ratio: continuous	Relative amount of discussion that was dedicated to unique information	(total number of unique item exchanges / number of unique items available) / (total number of item exchanges / total number of items available)
Sensemaking	Sensemaking attainment	Interval: continuous	Level of Sensemaking attainment by the team	5-item Likert scale in the post-session survey
Performance	Hidden profile discovery	Nominal: dichotomous	Hidden profile discovery of the team, i.e. whether the team decided to advise the humanitarian coordinator to send assistance to the best possible district given the information provided	0 = hidden profile district chosen 1 = other district chosen than hidden profile

to conduct a content analysis on all the teams' information sharing behaviors. Each time a team member would mention an information element accurately, i.e. so that their fellow team members would be informed on the critical content of that respective information element, we would register that as an exchanged information item. The first variable we define for information sharing is "fraction of different information items exchanged", which is the number of different information items that have been exchanged by a team divided by the number of different information items which they received before discussion. As we knew which information items were common and which ones were unique, we subsequently define the next two variables: "fraction of different common information items exchanged" is the number of different common information items that have been exchanged by a team divided by the number of different common information items which they received before discussion, and the "fraction of different unique information items exchanged" is the number of different unique information items that have been exchanged by a team divided by the number of different unique information items which they received before discussion.

It is also important to measure the teams' focus on unique information in their discussions. The effect of unique information on the group discussion is not only measured by counting the number of times unique information was mentioned by the team members. This information can be ignored or can be overshadowed by the discussion of common information. We therefore define the "unique item discussion ratio" variable measuring the degree of unique information sharing, which takes into account all information item exchanges, including the times that information items are repeated. The unique item discussion ratio represents the relative amount of discussion that was dedicated to unique information, and is defined as the ratio of unique items discussed (total number of unique item exchanges / unique items received before discussion) divided by the total items discussed (total number of item exchanges / total items received before discussion).

Please note that we use relative values for all information sharing variables, which depend on the number of information items received before discussion, instead of using absolute values. In this way we are able to meaningfully compare teams across information load treatments.

Sensemaking

We measured the "Sensemaking attainment" of teams through Likert scale items in the survey after the group discussions. The survey started by asking the participants about their confidence in their team's decision. The participants were highly convinced that they found the hidden profile: on average, individuals indicated on a 5-points Likert scale from 0 (strongly agree) to 4 (strongly disagree) on average 0.688 ($SD = 0.857$) that "I am confident about our final decision". It is important to note this positive performance perceivment, as this implies that practically all teams thought they had found the hidden profile and therefore were not "performance biased" in their response to the items measuring Sensemaking attainment.

As previously discussed in Chapter 4, the interrater reliability and non-independence analysis by means of ICC(1) of the Sensemaking attainment items resulted in a significant

group effect of the individual responses to five items, which warranted an aggregation of these responses by group. Mokken's nonparametric MHM scale analyses indicated that these five items constitute a reliable scale (Cronbach $\alpha = 0.768$). When each team's responses to the five items are summed together, it is possible to rank order the different teams according to one latent trait, their Sensemaking attainment. The five resulting variables used to measure group Sensemaking in humanitarian crisis response teams are: (1) effective use of social resources, (2) flow of the group process, (3) elaboration on initial situation awareness, (4) control of situation, and (5) perceived comprehensibility.

Performance

Performance is measured with one dichotomous variable, which takes value "1" if the hidden profile was found by the team – i.e. when the team advised the Humanitarian Coordinator to give priority for humanitarian assistance to the hidden profile district – and value "0" if the hidden profile was not found.

5.5 Results

Section 5.4.5 presented the variables that we use for the analysis. To test whether higher and lower scoring teams on a continuous variable have different outcomes on a dependent variable, we split the sample in half according to the continuous variable distribution, and define a new dichotomous variable in which the lowest scoring teams on the respective continuous variable take value "0" and the highest scoring teams value "1".

Non-parametric data analysis techniques, which rely on fewer assumptions, are used because of the relatively small sample size of 48 teams. Univariate analyses techniques are employed to test the bivariate relationships between variables: Mann-Whitney U -test is used to test differences in the mean of a continuous variable between two subgroups, and Pearson's chi-square test of independence is used to test whether higher and lower scoring teams on a continuous variable (using the newly defined dichotomous variable) have different outcomes on a dependent variable. Finally, logistic regression is employed to test the multivariate research model as represented in Figure 5.2.

Table 5.3 shows the descriptive statistics of our sample, and the bivariate correlations are presented in Table 5.4. What was expected is that on average groups exchange a greater fraction of common information ($M = 0.560$, $SD = 0.0263$) than unique information ($M = 0.320$, $SD = 0.207$). The bivariate correlations at first seem to be in line with our expectations. All relationships in our research model show significant correlations, except for the relationships between GSS setting and Sensemaking, information load and Sensemaking, and Sensemaking and information sharing (focus on unique information).

We proceed by testing all hypotheses one by one, as shown in our research model (Figure 5.2) and defined previously in Section 5.3. In Subsection 5.5.1 we test the influence of GSS setting on information sharing and Sensemaking. In Subsection 5.5.2 we test the

Table 5.3: Descriptive statistics ($N=48$)

Variable	Mean	SD	Minimum	Maximum
GSS setting	0.500	0.500	0	1
Information load	0.500	0.500	0	1
Fraction of total items exchanged	0.410	0.221	0.013	0.911
Fraction of common items exchanged	0.560	0.263	0.030	1
Fraction of unique items exchanged	0.320	0.207	0	0.867
Unique item discussion ratio	0.681	0.168	0	0.893
Sensemaking attainment	13.694	2.251	6.667	17.333
Hidden profile discovery	0.313	0.468	0	1

influence of information load on information sharing and Sensemaking. In Subsection 5.5.3 we test the influence of information sharing on performance. In Subsection 5.5.4 we test the influence of Sensemaking on information sharing and performance. In Subsection 5.5.5 we further investigate the importance of Sensemaking in the discovery of hidden profiles. Finally, in Subsection 5.5.6 we present a multivariate analysis of our research model.

5.5.1 Influence of GSS setting on information sharing and Sensemaking

The results of the influence of the GSS setting on Sensemaking attainment and the information sharing variables can be seen in Table 5.5. A Mann-Whitney U -test is used to compare the information exchange means of the teams in traditional GSS setting (radio and face-to-face) to the teams in the new GSS setting (chat). Teams in the traditional GSS setting exchange a significantly larger fraction of total items ($M = 0.543$, $SD = 0.195$) than teams in the new GSS setting ($M = 0.277$, $SD = 0.158$), with a Mann-Whitney U -statistic of 83.0 and $p < 0.01$. When further examining the data, we can see that in the first part of the experiment, teams communicating by radio are already exchanging a larger fraction of total items ($M = 0.203$, $SD = 0.148$) than teams communicating by chat ($M = 0.110$, $SD = 0.059$). In the second part of the experiment, when teams in the traditional GSS setting could convene face-to-face instead of using radio communication, these teams exchange an even larger fraction of total items ($M = 0.474$, $SD = 0.177$) than teams communicating by chat ($M = 0.187$, $SD = 0.149$).

Similarly, Table 5.5 shows that teams in the traditional GSS setting exchange a significantly larger fraction of common items ($M = 0.708$, $SD = 0.231$) than teams in the new GSS setting ($M = 0.413$, $SD = 0.208$), with a Mann-Whitney U -statistic of 93.0 and $p <$

Table 5.4: Bivariate Pearson correlations of all variable pairs ($N=48$)

	GSS setting	Information load	Fraction of items exchanged	Fraction of total items exchanged	Fraction of common items exchanged	Unique item cussion ratio	Sensemaking attainment	Hidden profile discovery
GSS setting	Correlation 1 Significance							
Information load	Correlation 0.000 Significance 1.000	1						
Fraction of total items exchanged	Correlation -0.607*** Significance 0.000	-0.294** 0.043	1					
Fraction of common items exchanged	Correlation -0.566*** Significance 0.000	-0.430*** 0.002	0.966*** 0.000	1				
Fraction of unique items exchanged	Correlation -0.597*** Significance 0.000	-0.269* 0.064	0.985*** 0.000	0.914*** 0.000	1			
Unique item discussion ratio	Correlation -0.138 Significance 0.348	-0.032 0.832	0.599*** 0.000	0.491*** 0.000	0.650*** 0.000	1		
Sensemaking attainment	Correlation -0.243* Significance 0.096	0.125 0.398	0.258* 0.077	0.200 0.173	0.271* 0.062	0.187 0.203	1	
Hidden profile discovery	Correlation -0.135 Significance 0.361	0.225 0.125	0.461*** 0.001	0.373*** 0.009	0.474*** 0.001	0.376*** 0.008	0.442*** 0.002	1

*** Correlation is significant at the 0.01 level (2-tailed)

** Correlation is significant at the 0.05 level (2-tailed)

* Correlation is significant at the 0.1 level (2-tailed)

0.01. Teams in the traditional GSS setting also exchange a significantly larger fraction of unique items ($M = 0.442$, $SD = 0.192$) than teams in the new GSS setting ($M = 0.198$, $SD = 0.139$), with a Mann-Whitney U -statistic of 89.5 and $p < 0.01$.

Hence, we cannot reject hypothesis 1a that teams supported by simple text-based GSS exchange relatively less information than teams discussing through radio and face-to-face.

Furthermore, Table 5.5 shows the Mann-Whitney U -test revealing that there is no significant difference in the relative amount of discussion that is dedicated to unique information (“unique item discussion ratio”) between the traditional GSS setting ($M = 0.704$, $SD = 0.185$) and the new GSS setting ($M = 0.658$, $SD = 0.149$), with a Mann-Whitney U -statistic of 213.0 and $p > 0.1$. Hence, we cannot reject hypothesis 1b that there is no difference between teams supported by simple text-based GSS and teams discussing through radio and face-to-face in their focus on unique information in discussions.

However, Hypothesis 2, stating that teams supported by simple text-based GSS attain higher Sensemaking than teams discussing through radio and face-to-face, has to be rejected. A Mann-Whitney U -test shows no significant differences between the Sensemaking attainment of teams in the traditional GSS setting ($M = 14.236$, $SD = 1.917$) and teams in the new GSS setting ($M = 13.153$, $SD = 2.463$), with a Mann-Whitney U -statistic of 223.0 and $p > 0.1$.

5.5.2 Influence of information load on information sharing and Sensemaking

Table 5.6 presents the results of the influence of information load on both mediating variables. A Mann-Whitney U -test reveals that teams exposed to lower information loads exchange a significantly larger fraction of total items ($M = 0.474$, $SD = 0.226$) than teams exposed to higher information loads ($M = 0.346$, $SD = 0.200$), with a Mann-Whitney U -statistic of 197.0 and $p < 0.1$. Similarly, teams exposed to lower information loads exchange a significantly larger fraction of common items ($M = 0.672$, $SD = 0.236$) than teams exposed to higher information loads ($M = 0.448$, $SD = 0.245$), with a Mann-Whitney U -statistic of 150.0 and $p < 0.01$, and a significantly larger fraction of unique items ($M = 0.375$, $SD = 0.227$) than teams exposed to higher information loads ($M = 0.265$, $SD = 0.172$), with a Mann-Whitney U -statistic of 199.0 and $p < 0.1$. Hence, hypothesis 3a, indicating that teams exposed to lower information loads exchange relatively more information than teams exposed to higher information loads, cannot be rejected.

A Mann-Whitney U -test reveals that there is no difference in the relative amount of discussion that is dedicated to unique information (“unique item discussion ratio”) between teams exposed to lower information loads ($M = 0.686$, $SD = 0.136$) and teams exposed to higher information loads ($M = 0.676$, $SD = 0.197$), with a Mann-Whitney U -statistic of 287.0 and $p > 0.1$. We have to reject hypothesis 3b which states that teams exposed to higher information loads focus relatively less on unique information in their discussions than teams exposed to lower information loads.

The Mann-Whitney U -test on differences in Sensemaking means, as presented in Ta-

Table 5.5: Mann-Whitney U -tests of the GSS condition

Variable		Traditional GSS setting $N = 24$	New GSS setting $N = 24$
Fraction of total items exchanged	Mean	0.543	0.277
	SD	0.195	0.158
	Mean rank	33.04	15.96
	<i>Pairwise comparison:</i>	<i>Traditional vs. New</i>	
	Mann-Whitney U -statistic Significance	83.0*** 0.000	
Fraction of common items exchanged	Mean	0.708	0.413
	SD	0.231	0.208
	Mean rank	32.63	16.38
	<i>Pairwise comparison:</i>	<i>Traditional vs. New</i>	
	Mann-Whitney U -statistic Significance	93.0*** 0.000	
Fraction of unique items exchanged	Mean	0.442	0.198
	SD	0.192	0.139
	Mean rank	32.77	16.23
	<i>Pairwise comparison:</i>	<i>Traditional vs. New</i>	
	Mann-Whitney U -statistic Significance	89.5*** 0.000	
Unique item discussion ratio	Mean	0.704	0.658
	SD	0.185	0.149
	Mean rank	27.63	21.38
	<i>Pairwise comparison:</i>	<i>Traditional vs. New</i>	
	Mann-Whitney U -statistic Significance	213.0 0.122	
Sensemaking Attainment	Mean	14.236	13.153
	SD	1.917	2.463
	Mean rank	27.21	21.79
	<i>Pairwise comparison:</i>	<i>Traditional vs. New</i>	
	Mann-Whitney U -statistic Significance	223.0 0.180	

*** Difference in the mean is significant at the 0.01 level

Table 5.6: Mann-Whitney U -tests of the information load condition

Variable		Low information load $N = 24$	High information load $N = 24$
Fraction of total items exchanged	Mean	0.474	0.346
	SD	0.226	0.200
	Mean rank	28.29	20.71
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	197.0*	
	Significance	0.060	
Fraction of common items exchanged	Mean	0.672	0.448
	SD	0.236	0.245
	Mean rank	30.25	18.75
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	150.0***	
	Significance	0.004	
Fraction of unique items exchanged	Mean	0.375	0.265
	SD	0.227	0.172
	Mean rank	28.21	20.79
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	199.0*	
	Significance	0.066	
Unique item discussion ratio	Mean	0.686	0.676
	SD	0.136	0.197
	Mean rank	24.46	24.54
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	287.0	
	Significance	0.984	
Sensemaking Attainment	Mean	13.417	13.972
	SD	2.170	2.342
	Mean rank	21.98	27.02
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	227.5	
	Significance	0.212	

*** Difference in the mean is significant at the 0.01 level

* Difference in the mean is significant at the 0.1 level

ble 5.6, shows that there is no difference in Sensemaking attainment between teams exposed to lower information loads ($M = 13.417$, $SD = 2.170$) and teams exposed to higher information loads ($M = 13.972$, $SD = 2.342$), with a Mann-Whitney U -statistic of 227.5 and $p > 0.1$. Hence, hypothesis 4, that teams exposed to higher information loads attain higher Sensemaking than teams exposed to lower information loads, has to be rejected.

5.5.3 Influence of information sharing on performance

In order to test the difference between teams that exchange more and fewer information items, we define three new dichotomous variables with values “0” for the 24 teams with lowest fraction of (total/common/unique) information items exchanged and values “1” for the 24 teams with highest fraction of (total/common/unique) information items exchanged. A Pearson’s chi-square test of independence is performed to examine the relationship between fraction of information items that are exchanged by the teams and performance, of which the results are displayed in Table 5.7. The discovery of the hidden profile district is significantly related to the fraction of total items exchanged, $\chi^2(1, N = 48) = 11.733$, $p < 0.01$. The discovery of the hidden profile district is also significantly related to the fraction of unique items exchanged, $\chi^2(1, N = 48) = 11.733$, $p < 0.01$. However, the discovery of the hidden profile district is not significantly related to the fraction of common items exchanged, $\chi^2(1, N = 48) = 2.424$, $p > 0.1$. Higher information sharing teams, and in particular teams that exchange relatively more unique information items, are more likely to discover the hidden profile than lower information sharing teams. More common information exchange on its own does not lead to a significant increase in performance. Therefore, we cannot reject hypothesis 5a, that teams that exchange relatively more information perform better than teams that exchange relatively less information, but note that this is only valid for all items together or all unique information items, not all common information items in itself.

In order to test the relationship between more and less focus on unique information and performance, we define a new dichotomous variables with values “0” for the 24 teams with lowest unique item discussion ratio and values “1” for the 24 teams with highest unique item discussion ratio. A chi-square test of independence reveals that the discovery of the hidden profile is significantly related to the relative amount of discussion that is dedicated to unique information (“unique item discussion ratio”), $\chi^2(1, N = 48) = 4.752$, $p < 0.05$, and can also be seen in Table 5.7. This shows that teams that focus relatively more on unique information in their discussions perform better than teams that focus relatively less on unique information in their discussion. Hence, we cannot reject hypothesis 5b.

5.5.4 Influence of Sensemaking on information sharing and performance

In order to test the difference between teams that attain lower and higher Sensemaking, we define a new dichotomous variable with values “0” for the 24 teams with lowest Sensemaking attainment (≤ 13.67), and values “1” for the 24 teams with highest Sensemaking

Table 5.7: Chi-square tests of independence for hidden profile discovery

	Fraction of total items exchanged		Fraction of common items exchanged		Fraction of unique items exchanged		Unique item discussion ratio		Sensemaking attainment	
	Low (≤ 0.39)	High (≥ 0.44)	Low (≤ 0.58)	High (≥ 0.60)	Low (≤ 0.27)	High (≥ 0.33)	Low (≤ 0.742)	High (≥ 0.744)	Low (≤ 13.67)	High (≥ 14.33)
Wrong decision	22	11	19	14	22	11	20	13	21	12
Correct decision	2	13	5	10	2	13	4	11	3	12
	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$	$N = 24$
Pearson chi-square	$\chi^2 = 11.733^{***}$		$\chi^2 = 2.424$		$\chi^2 = 11.733^{***}$		$\chi^2 = 4.752^{**}$		$\chi^2 = 7.855^{***}$	
Significance	0.001		0.119		0.001		0.029		0.005	

*** The relationship is significant at the 0.01 level

** The relationship is significant at the 0.05 level

attainment (≥ 14.33). A Mann-Whitney U -test, presented in Table 5.8, reveals that there is a significant difference in the relative amount of discussion that is dedicated to unique information (“unique item discussion ratio”) between teams with lower Sensemaking attainment ($M = 0.629$, $SD = 0.194$) and teams with higher Sensemaking attainment ($M = 0.733$, $SD = 0.118$), with a Mann-Whitney U -statistic of 190.0 and $p < 0.05$. Hypothesis 6, stating that teams that attain higher Sensemaking focus relatively more on unique information than teams that attain lower Sensemaking, cannot be rejected.

Table 5.8: Mann-Whitney U -tests of the influence of Sensemaking on the focus on unique information

Variable		Low Sensemaking attainment (≤ 13.67) $N = 24$	High Sensemaking attainment (≥ 14.33) $N = 24$
Unique item discussion ratio	Mean	0.629	0.733
	SD	0.194	0.118
	Mean rank	20.42	28.58
	<i>Pairwise comparison:</i>		<i>Low vs. High</i>
	Mann-Whitney U -statistic	190.0**	
	Significance	0.043	

** Difference in the mean is significant at the 0.05 level

We use the same dichotomized Sensemaking attainment variable to test the relationship between Sensemaking and performance. A chi-square test of independence, presented in Table 5.7, reveals that the discovery of the hidden profile is significantly related to Sensemaking attainment, $\chi^2(1, N = 48) = 7.855$, $p < 0.01$. From the results we may infer that teams attaining higher Sensemaking are more likely to discover the hidden profile than teams attaining lower Sensemaking. Hence, we cannot reject hypothesis 7 that teams that attain higher Sensemaking perform better than teams that attain lower Sensemaking.

5.5.5 The hidden factor: Sensemaking

Literature already revealed the crucial role of *information sharing* in the discovery of hidden profiles. To further investigate the importance of *Sensemaking* in the discovery of hidden profiles besides information sharing, we examine whether Sensemaking is the determining factor for high information sharing teams in finding the hidden profile or not. For this we use the same dichotomized “fraction of total items exchanged” variable. The 24 teams that exchange most information measured by this variable have a mean value of 0.54 on performance, i.e., 54% of the highest information exchanging teams found the hidden profile. We expect that Sensemaking plays an important role in this. A Mann-Whitney U -test reveals that there is a significant difference in Sensemaking attainment between

teams that exchange a lot of information and do not find the hidden profile ($M = 13.758$, $SD = 1.814$) and teams that exchange a lot of information and find the hidden profile ($M = 15.128$, $SD = 1.405$), with a Mann-Whitney U -statistic of 42.5 and $p < 0.1$. As Table 5.9 shows, Sensemaking is the only variable on which there is a significant difference between finding the hidden profile and not-finding the hidden profile when exchanging a lot of information. There is no significant difference in GSS setting (Mann-Whitney $U = 42.5$, $p > 0.1$), information load (Mann-Whitney $U = 47.0$, $p > 0.1$), fraction of total items exchanged (Mann-Whitney $U = 69.5$, $p > 0.1$), fraction of common items exchanged (Mann-Whitney $U = 62.5$, $p > 0.1$), fraction of unique items exchanged (Mann-Whitney $U = 67.0$, $p > 0.1$), and unique item discussion (Mann-Whitney $U = 63.0$, $p > 0.1$). In sum, we observe that the Sensemaking attainment of teams that exchange relatively much information, *ceteris paribus*, determines their performance.

5.5.6 Multivariate analysis: A model for group decision making in humanitarian crisis response

Until now we have tested the relationship between all variables of our research model presented in Figure 5.2 separately, as is a common endeavor in IS research. However, there are several disadvantages and pitfalls to this, such as inflated type I error rates and non-independence of variables (Tabachnick and Fidell, 2007, pp.243-244), which makes it necessary to validate the model by testing all variables at once. We choose to use logistic regression because of its flexibility of including different types of variables in the same model and its non-parametric nature.

Looking back at the bivariate correlations in Table 5.4, we can see that there are high correlations between several pairs of variables. In those cases where bivariate correlations are above 0.90 we encounter a *multicollinearity* problem: variables contain redundant information which could lead to statistical problems in the analysis (Tabachnick and Fidell, 2007, pp.88-89). According to this definition, the three information sharing variables that measure the exchange of information show high (> 0.90) and significant ($p < 0.01$) bivariate correlations with each other. We therefore have to exclude two of these variables in our logistic regression, and choose only to continue with “fraction of total items exchanged” because this captures the overall information exchange.

For ease of interpretation of the odds ratio, which will be discussed later on, we multiply all “fraction of total items exchanged” values by 100%, and proceed the next analysis with the variable renamed as “percentage of total items exchanged”. We conduct a logistic regression with “hidden profile discovery” as dependent variable and “GSS setting”, “information load”, “percentage of total items exchanged”, “unique item discussion ratio”, and “Sensemaking attainment” as independent variables.

The Wald chi-square statistic tests the unique contribution of each independent variable, holding constant the other independent variables. The first logistic regression analysis reveals that all variables are significant except for the “unique item discussion ratio” with $\chi^2(1, N = 48) = 0.014$, $p > 0.1$. When keeping all other variables constant, the unique

Table 5.9: Mann-Whitney U -tests investigating what leads to high performance for the 24 highest information sharing teams (fraction of total items exchanged ≥ 0.44)

Variable		Hidden profile discovery = 0 $N = 11$	Hidden profile discovery = 1 $N = 13$
Sensemaking Attainment	Mean	13.758	15.128
	SD	1.814	1.405
	Mean rank	9.86	14.73
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	42.5*	
	Significance	0.093	
GSS setting	Mean	0.091	0.308
	SD	0.302	0.480
	Mean rank	11.09	13.69
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	56.0	
	Significance	0.392	
Information load	Mean	0.273	0.615
	SD	0.467	0.506
	Mean rank	10.27	14.38
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	47.0	
	Significance	0.167	
Fraction of total items exchanged	Mean	0.589	0.604
	SD	0.111	0.134
	Mean rank	12.32	12.65
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	69.5	
	Significance	0.910	
Fraction of common items exchanged	Mean	0.788	0.754
	SD	0.122	0.165
	Mean rank	13.32	11.81
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	62.5	
	Significance	0.608	
Fraction of unique items exchanged	Mean	0.479	0.508
	SD	0.125	0.139
	Mean rank	12.09	12.85
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	67.0	
	Significance	0.820	
Unique item discussion ratio	Mean	0.758	0.787
	SD	0.071	0.065
	Mean rank	11.73	13.15
	<i>Pairwise comparison:</i>	<i>Low performance vs. High performance</i>	
	Mann-Whitney U -statistic	63.0	
	Significance	0.649	

* Difference in the mean is significant at the 0.1 level

item discussion ratio does not appear to significantly contribute to the prediction of the hidden profile discovery. We therefore run a second logistic regression analysis, identical to the first, with the only change made that “unique item discussion ratio” is excluded. The output can be seen in Table 5.10.

Table 5.10: Multivariate logistic regression analysis

Variable	B	S.E.	Wald χ^2	df	Sig.	Odds ratio
GSS setting	3.904	1.991	3.844**	1	0.050	49.581
Information load	4.641	1.927	5.803**	1	0.016	103.673
Percentage of total items exchanged	0.185	0.069	7.216***	1	0.007	1.204
Sensemaking attainment	0.773	0.366	4.455**	1	0.035	2.167
Constant	-24.844	8.604	8.337***	1	0.005	0.000
Omnibus Chi-square test of model coefficients (4df) = 34.867, $p < 0.01$						
Hosmer and Lemeshow Chi-square test (8df) = 4.060, $p = 0.852$						
Nagelkerke $R^2 = 0.726$						

Note: “unique item discussion ratio” is not included because it is not significant ($p = 0.905$)

*** Variable is significant at the 0.01 level

** Variable is significant at the 0.05 level

All variables in the equation are tested with a Wald chi-square test with the null hypothesis that the coefficient equals 0. The null hypothesis must be rejected for all coefficients, as they all appear to be significantly different from 0, with $p < 0.05$ (two-tailed). The overall model (omnibus test of model coefficients) is significant, with a chi-square statistic of $\chi^2(4, N = 48) = 34.867$, $p < 0.01$. The Hosmer and Lemeshow chi-square test, which tests the null hypothesis that there is a linear relationship between the independent variables and the log odds of the dependent variable, is non-significant, $\chi^2(8df) = 4.060$, $p > 0.1$, indicating that the data fit the model well. The effect size of the model, measured by Nagelkerke’s R^2 which approximates the variance interpretation of R^2 for linear regression (Tabachnick and Fidell, 2007, p.460), is 0.726.

First, we interpret the variable coefficients from Table 5.10, and in particular the odds ratios shown in the last column. The 49.581 odds ratio for GSS setting indicates that the odds of finding the hidden profile are nearly 50 times larger for teams in new GSS settings (chat) than in traditional GSS settings (radio and face-to-face), *ceteris paribus*. Similarly, the 103.673 odds ratio for information load indicates that the odds of finding the hidden profile are more than 100 times larger for teams exposed to higher information loads than teams exposed to lower information loads, *ceteris paribus*. The 1.204 odds ratio for percentage of total items exchanged indicates that if a team exchanges one percent more of the available information items, *ceteris paribus*, the odds of finding the hidden profile increases with 20%. Finally, the 2.167 odds ratio for Sensemaking attainment indicates that a one-unit increase in a team’s Sensemaking attainment, *ceteris paribus*, results in a more than twice larger odds for finding the hidden profile.

To predict the dependent variable for a given value of each independent variable, we can use the predicted variable coefficients (shown in the second column of Table 5.10, labeled as “B”) in the following logistic regression equation:

$$odds = \exp(-24.844 + 3.904 * X_1 + 4.641 * X_2 + 0.185 * X_3 + 0.773 * X_4), \quad (5.1)$$

where X_1 = GSS setting, X_2 = information load, X_3 = percentage of total items exchanged, and X_4 = Sensemaking attainment. The outcome of this equation is the odds of finding the hidden profile.

To obtain the probability of discovering the hidden profile from the odds equation, we can use the following formula:

$$Probability = \frac{odds}{1 + odds}. \quad (5.2)$$

When using the decision rule that teams with a predicted probability of the model larger than 0.5 are likely to discover the hidden profile, the logistic regression model was able to correctly classify 73.3% of the teams that discovered the hidden profile, and 93.9% of those who did not, for an overall success rate of 87.5% (see Table 5.11).

Table 5.11: Classification of predicted performance by logistic regression model

		Predicted hidden profile discovery		Percentage
		wrong decision	correct decision	correct
Observed hidden profile discovery	wrong decision	31	2	93.9
	correct decision	4	11	73.3
Overall percentage				87.5

In Figure 5.3 the predicted probability is displayed, along with the related values of the two mediating variables, Sensemaking attainment and percentage of total items exchanged (displayed as a fraction in the graph in order to use the same vertical axis on the right hand side), as well as the actual discovery of the hidden profile by the respective team. The horizontal axis represents the teams, ordered first by actual hidden profile discovery and second by predicted performance according to the logistic regression model. The left vertical axis presents the Sensemaking attainment scores, and the right vertical axis presents the values of the other variables. As can be seen, increasing trends in Sensemaking and fraction of total items exchanged causes the predicted hidden profile discovery to increase. The first 33 teams in Figure 5.3 did not discover the hidden profile. The two

teams that are predicted to discover the hidden profile as shown in Table 5.11 but that did not, whose results are displayed just before the steep increase of “actual hidden profile discovery”, have relatively high values on the two mediating variables. Therefore they have a predicted probability higher than 0.5 to find the hidden profile. The four teams that are predicted not to discover the hidden profile but who actually did, whose results are displayed as teams 34 until 37 just after the steep increase of “actual hidden profile discovery”, have relatively low values on the two mediating variables. Therefore, they are predicted not to discover the hidden profile. In general we can observe higher average values for Sensemaking attainment and fraction of total items exchanged for the teams that discovered the hidden profile (the right hand side of the graph).

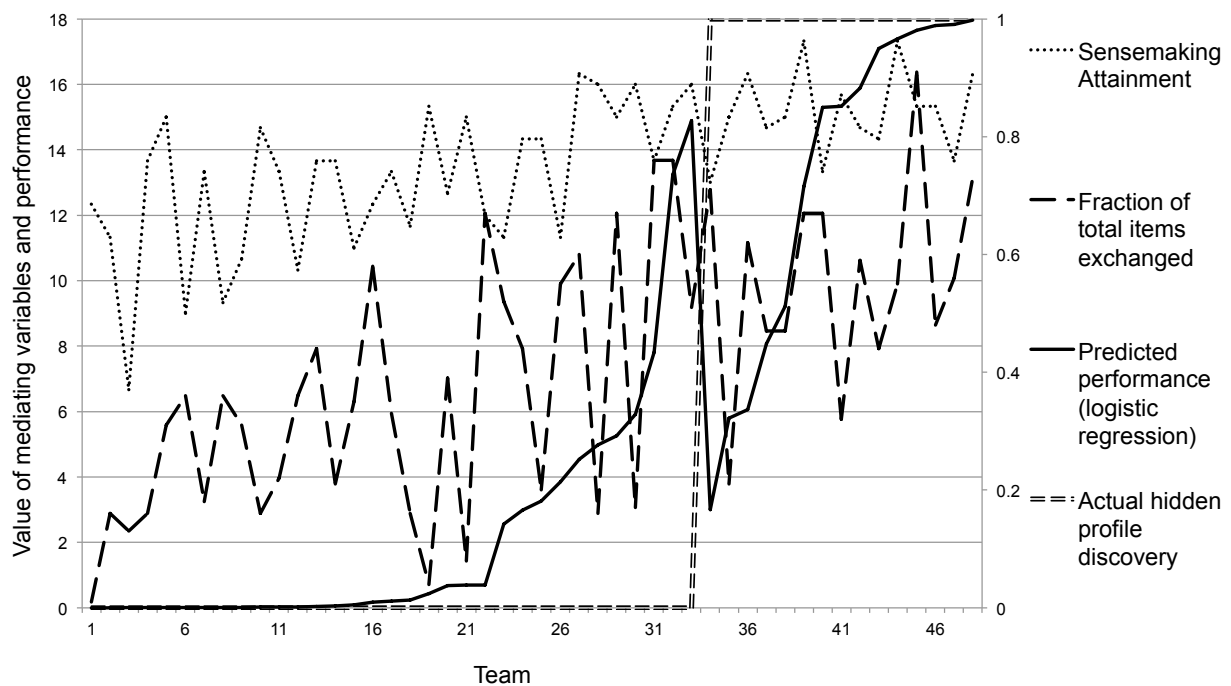


Figure 5.3: Logistic regression prediction of team performance, along with the respective team’s scores on the mediating variables and their actual performance

5.6 Discussion and Chapter Conclusions

Through participant observation in the Triplex humanitarian crisis response exercise we got an insider’s perspective of the humanitarian needs assessment process. We used this context to base our hidden profile study on. The hidden profile experiment reflected the practice of specific humanitarian crisis response teams: when making needs assessments,

they are individually aware of a subset of the total information pool, and form arguments and tentative preferences and conclusions based on this subset.

Our hypothesis (H5a) that more information exchange leads to better performance is partly rejected. More exchange of common information items in itself appears not to lead to better performance, but more information exchange in general and exchange of unique information items in particular does lead to better performance. This makes sense, as common information is not information that is new to other team members, and therefore does not contribute to better informed decisions. In line with this observed importance of unique information, we are also unable to reject the hypothesis (H5b) that teams with a higher focus on unique information in the discussions perform better than teams with a lower focus on unique information. The fact that the unique item discussion ratio is not significant in the logistic regression model does not mean that it is not an important variable in our model, but rather that it does not have sufficient added value to predict the dependent variable when considering all variables together. This highlights the importance of testing a research model multivariately, as only then it can be assessed whether a variable has a unique contribution.

Prior research has indicated that more information sharing, *ceteris paribus*, does not increase performance in group decision making (Mennecke, 1997). There seemed to be an unobservable influence on performance besides information sharing, called among others “cognitively processing of information that is surfaced” (Mennecke, 1997). Our study identifies and measures this “mythical” process in group decision making: Sensemaking. Firstly, we cannot reject the hypothesis (H6) that teams which attain higher Sensemaking focus relatively more on unique information. We have found further evidence for the importance of Sensemaking, as we cannot reject the hypothesis (H7) that higher Sensemaking attainment results in better performance. Finally, it appears that a large amount of information exchange on its own does not automatically lead to a high performance, but that Sensemaking is a significant mediating factor, which largely determines success or failure in these cases. The logistic regression analysis confirms the importance of Sensemaking, with a more than double increase in odds to find the hidden profile for a one-unit increase in a team’s Sensemaking attainment. We expect that the effect of Sensemaking will only be stronger in real-life humanitarian crisis response group decision making, as there is no set of decision alternatives available for such teams and these alternatives and subsequent exploration of alternatives by information search, triangulation, and decision making has to be extensively shaped through processes of Sensemaking.

We investigated the effect of GSS setting on information sharing and Sensemaking through two different treatments. Information exchange appears to be higher in traditional GSS settings (with radio and face-to-face communication) than in new GSS settings (chat communication), and we cannot reject hypothesis 1a. The significant difference in information exchange is evidently not only caused by the face-to-face discussion, as teams communicating by radio are already exchanging more information in the first part of the experiment. This supports our stated expectation that the higher rehearsability that is needed for text-based communication outweighs the marginal positive effect of parallelism. As we expected, the unstructured GSS support used by teams in the new GSS setting does

not lead to positive influence of their potential advantage of group memory usage (H1b).

We also hypothesized (H2) that each of the two GSS settings have advantages and disadvantages for social Sensemaking, but that the traditional setting is worse for ongoing Sensemaking than the new setting. We observed no significant difference in Sensemaking between the two GSS settings. In such a group Sensemaking setting, the social aspect plays an important role, and we have previously seen (Chapter 3 and Muhren and Van de Walle, 2010d) that social Sensemaking needs different types of support, depending on the type of interaction that is needed. When needing to inquire, verify, and reflect, Sensemaking teams benefit from a more direct communication process (higher transmission velocity and lower parallelism), and when needing to triangulate information, text-based communication is better due to its higher parallelism. Our findings confirm that Sensemakers are in need of different types of support, and should be able to switch to the appropriate media characteristic that is needed at different moments during an ongoing (decision making) process.

The logistic regression analysis reveals that *ceteris paribus* teams in new GSS settings perform far better than teams in traditional GSS settings, with an odds ratio of finding the hidden profile that is 50 times higher. This means that in the hypothetical situation that traditional GSS teams and new GSS teams exchange the same amount of information and attain the same level of Sensemaking, new GSS teams will perform much better. When considering the univariate analysis it seems however unrealistic to assume that all other variables can be kept equal, as GSS setting has a demonstrated effect on information sharing, and teams in traditional GSS settings exchange significantly more information. Given this fact and our finding that the GSS setting does not have an effect on Sensemaking, we may conclude that the traditional GSS setting is better for humanitarian crisis response teams than the new GSS setting for information sharing and subsequently performance. A possibly new GSS setting will have to be adapted to better support information sharing and Sensemaking.

We also investigated the influence of lower and higher information loads that teams are exposed to on information sharing and Sensemaking. Our hypothesis (H3a) that in a condition of low information load proportionally more information is exchanged cannot be rejected. There is, however, no evidence for a difference in focus on unique information between the different information load conditions (H3b). In our higher information load condition teams are most probably not exposed to a too extremely high information load, i.e., information overload, for which Sutcliffe and Weick (2008) expected problems in focus on relevant (i.e., unique) information.

Weick's suggestion that more information does not necessarily lead to better Sensemaking is confirmed by our rejection of Hypothesis 4. Teams exposed to higher information loads do not attain higher Sensemaking than teams exposed to lower information loads.

Similarly to the case with the GSS setting, it is not realistic to assume that the mediating variables do not change when comparing the different information load conditions to each other. Because teams in lower information load are able to exchange relatively more information than teams in higher information load, and information load does not influence Sensemaking attainment, we may conclude that lower information load facilitates

better information sharing and therefore performance in group decision making.

In practice, however, humanitarian response teams are exposed to high information loads. Since high information loads lead to relatively less information exchange, the teams' Sensemaking attainment becomes especially important to determine their performance. Sensemaking appears to be an exogenous variable in our experiment, as neither information load nor GSS setting demonstrates a significant effect on it. Interestingly only Sensemaking, and neither information load nor GSS setting has a significant effect on the focus on unique information, while this focus has a significant effect on performance. Additionally, we have found Sensemaking to be the determining factor for high performance when information sharing is high in a team. For a long time Sensemaking was the hidden factor in group decision making, unknowingly playing an important role in the discovery of hidden profiles. Now these steps are made in measuring Sensemaking and identifying its influence, SSS should be developed to support decision making teams and avoid the failure of missing hidden profiles in real-life humanitarian crisis response.

5.6.1 Limitations of this research

The usual limitations of experimental research (Shadish et al., 2002) apply to our study. Laboratory experimental settings are known for their high internal validity but relatively low external validity and construct validity. Threats to internal validity were reduced by random assignment of individuals to teams and random assignment of teams to treatments, by following the same protocol across all sessions, and by having humanitarian crisis response experts validate the case. Threats to external validity and construct validity were reduced by financially compensating students, rewarding good performance with iPods, grounding the case on real-life crisis management experiences, and simulating real-life needs assessment teams in many aspects (such as by using handheld transceivers, terminology common to practice, maps actually developed by a humanitarian NGO, etc.). But because undergraduate and graduate students were used with no humanitarian crisis response experience, working with assumably less passion and motivation than real humanitarian crisis responders, and working to solve a highly simplified case when compared to a real crisis, under far less stringent pressure and environmental turbulence, our findings cannot readily be generalized to real-life settings. Additional research in humanitarian crisis response settings, such as through a field experiment, is needed to validate our findings.

A further limitation of this research is that the participant observation experiences, on which the laboratory experiment was based, were gained at a humanitarian response exercise rather than at an actual humanitarian response mission. Although the Triplex exercise had all the features of a real mission, the processes that took place (e.g., needs assessment) were in essence experimented with and simulated. Hence, additional research is needed in real-life humanitarian crisis response settings to validate our Triplex findings.

Although we had to conclude that teams in traditional GSS settings exchange more information and hence perform better than teams in new GSS settings, we cannot state that teams in traditional GSS settings will perform better in real-life. Teams in our simulated new GSS setting would experience an enormous efficiency gain by using a simple text-based

communication device throughout their needs assessments, as they do not lose time and do not have to overcome problematic traveling issues to convene face-to-face. It was not feasible to take into account this time gain in our experimental setup, but this is expected to play an important role in practice.

Our study simulated humanitarian needs assessment teams without taking the UNDAC staff members in the OSOCC into account. At Triplex we observed that OSOCC staff members were only briefed of the assessments when the team's needs assessment process had finalized. A suggestion towards humanitarian response practice is that IS should connect both the assessment teams and the information managers in the OSOCC in real-time. This will support Sensemaking by encouraging conversation and enabling resilience, will enable prior identification and usage of important unique information, and will facilitate faster decision making for the international humanitarian response.

5.6.2 Implications for research and practice

In Triplex and other former studies we identified the importance of Sensemaking in real-life crisis response and hypothesized how Sensemaking could be more effectively supported. In this chapter we have taken this a step further, and have shown that it is possible to measure Sensemaking and quantitatively validate its importance in group decision making and humanitarian crisis response. This achievement can take the study of SSS to the next level. Information systems designers and developers and policy makers now have a means to objectively verify whether the systems, organizational structures, and policies they put in place – in humanitarian crisis response or in other contexts – lead to an increase or decrease of Sensemaking support for the actors involved.

We have developed a hidden profile study, which can be used by other researchers to simulate a humanitarian crisis response setting in laboratory and field experiments.

We have moreover identified the importance of Sensemaking in the discovery of hidden profiles, which might provide explanations to other hidden profile researchers why some teams find hidden profiles and some teams do not when they only take into account information sharing as mediating variable.

Information systems are generally conceived as a “repository of best practice” model (Boland and Yoo, 2003) which puts an emphasis on data storage. We have however confirmed Weick (1995)'s suggestion that more information does not automatically lead to better Sensemaking. IS should thus be designed to connect people, to stimulate reflection and the quality of interaction, and to support building the team's own story line as first priority rather than the current focus on the search for and storage of information. A practical implication of this finding is that it could be more important to focus on the processing of existing information than the collection of new assessment information, also because in conditions of higher information load relatively less information appeared to be exchanged. To enable better performance, the usual quantitative information-focused mindset of “more is better” should be changed into a more qualitative and interpretive information processing-focused mindset based on Sensemaking.

Chapter 6

Conclusions

Nihil est (...) simul et inventum et perfectum.

Cicero

In Section 1.4 we presented our problem statement and formulated eight research questions as a guideline for answering it. Based on our findings presented in Chapters 2–5 we answer the research questions (Section 6.1) and the problem statement (Section 6.2) and thereby summarize the contributions of this dissertation. Section 6.3 provides suggestions for future research.

6.1 Answers to the Research Questions

Research question 1. *How do actors process information in crisis situations?*

The answer to the first research question is derived from Chapter 2. In this chapter we provided rich insights into how actors process information in crisis situations. These findings validated our framework that actors' information processing activities are focused either on (1) information processing challenges based on *information* of uncertainty and complexity, the realm of decision making, or on (2) information processing challenges based on *frames of reference* of ambiguity and equivocality, the realm of Sensemaking. In the different crisis situations we studied, there was a common observation that actors' activities focused mainly on obtaining information (dealing with uncertainty) and creating a suitable frame of reference to interpret the information (dealing with ambiguity) at the onset of the response to the crisis. In contrast, as the response to the crisis developed over time, actors focused more on searching for the best ways to manage an overload of information (dealing with complexity) and choosing which frame of reference out of several to use to interpret the information (dealing with equivocality). However, the type and extent of the information processing challenges that need to be addressed depends on the specific

situation, and the approach of how these information processing challenges are dealt with depends on the actor.

Research question 2. *Can we validate the seven Sensemaking properties in crisis actors' information processing behavior?*

The answer to the second research question is derived from Chapter 2. In this chapter we presented our findings on the information processing behavior of crisis actors as studied in the DRC. Through interviews, and presented in the form of quotations, we could recognize and thereby validate all seven Sensemaking properties – social context, identity construction, retrospection, cue extraction, ongoing, plausibility, and enactment – in this behavior.

Research question 3. *What can we learn from crisis actors' information processing behavior for the design of Sensemaking Support Systems for crisis management?*

The answer to the third research question is derived from Chapter 2 and Chapter 5. In Chapter 2 we found that seven premises for designing crisis management IS – called DERMIS – contribute to the support of Sensemaking by enabling the dealing with frames of reference. Crisis management case studies have revealed that if crisis management systems are designed to support access to all contextual information (design premise 1) and storage of historical information and incorporation of lessons learned (design premise 2), actors are enabled to construct suitable frames of reference. If these systems are designed to be flexible during the response (design premise 3) and adaptable to the nature and scope of the crisis (design premise 4), actors are enabled to update and change their frames of reference. Finally, as general requirements, if systems facilitate interaction and collaboration by supporting timely and valid information exchange (design premise 5) without any impediments (design premise 6), ensuring effective coordination (design premise 7), actors are enabled to create, compare, update, and change their frames of reference.

Moreover, we demonstrated in Chapter 2 that all Sensemaking properties are reflected in these premises for designing IS. In Chapter 5 we provided suggestions through simple measures how the Sensemaking properties can be better supported by IS in the humanitarian needs assessment process.

Research question 4. *How does communication play a role in the Sensemaking processes of humanitarian actors in a crisis environment?*

The answer to the fourth research question is derived from Chapter 3. In this chapter we found that humanitarian actors in the DRC engage in eight different Sensemaking communication activities to reach individual understanding of the crisis situation: (1) noticing,

(2) updating, (3) inquiring, (4) triangulating, (5) verifying, (6) reflecting, (7) enacting, and (8) interpreting. Moreover, we found that humanitarian crisis actors continuously create and maintain an infrastructure, mostly informal and personal-based, for these Sensemaking communication activities.

Research question 5. *How can information systems support Sensemaking in humanitarian crisis response from a communications perspective?*

The answer to the fifth research question is derived from Chapter 3. In this chapter we found that humanitarian crisis actors are in need of different types of support depending on the purpose of communication, and identified three types of media for supporting the Sensemaking communication activities: (1) scanning media, (2) triangulating media, and (3) one-to-one media. These types of media will support humanitarian crisis actors' Sensemaking by supporting both institutional information and communication exchanges and exchanges in informal, personal networks.

Research question 6. *Can we measure group Sensemaking attainment in humanitarian crisis response?*

The answer to the sixth research question is derived from Chapter 4. In this chapter we established a reliable scale to measure group Sensemaking attainment in humanitarian crisis response, consisting of five survey items representing (1) the effective use of social resources, (2) the flow of the group process, (3) the elaboration on initial situation awareness, (4) the control of the situation, and (5) the perceived comprehensibility.

Research question 7. *How are Sensemaking and information sharing related to each other in humanitarian crisis response teams?*

The answer to the seventh research question is derived from Chapter 5. In this chapter we found that both information sharing and Sensemaking are information processing constructs. Sensemaking is shown to have a significant effect on the type of information that is discussed in a team: Sensemaking attainment positively affects the focus on unique information in team discussions. Moreover, it appeared that a large amount of information sharing on its own does not automatically lead to a high performance, but that Sensemaking is a significant mediating factor, which largely determines success or failure in these cases.

Research question 8. *Does Sensemaking attainment influence performance in humanitarian crisis response teams?*

The answer to the eighth research question is derived from Chapter 5. In this chapter we found that higher group Sensemaking attainment results in better team performance. Additionally, as the answer to research question 7 already stated, we have found Sensemaking to be the determining factor for high team performance when information sharing is high.

6.2 Answer to the Problem Statement

Problem statement. *To what extent can we lay the foundations of Sensemaking Support Systems for humanitarian crisis response?*

The answer to the problem statement is based on the answers to the eight research questions discussed in the previous section. This allows us to formulate three general foundations of Sensemaking Support Systems for humanitarian crisis response.

The first foundation is a more advanced understanding of Sensemaking in humanitarian crisis response. It consists of (1) an in-depth exploration of what needs to be supported in humanitarian crisis response – Sensemaking – and (2) making this process more explicit. With respect to the first part, our research demonstrates that Sensemaking is about the interpretive aspect of information processing, namely how crisis actors construct and choose a frame of reference for interpreting information. Sensemaking is characterized by seven properties, all verified to be present in information processing behavior in crises. Furthermore, we demonstrated that Sensemaking is of crucial importance in humanitarian crisis response. With respect to the second part, we provided a detailed overview of the different types of Sensemaking communication activities that are undertaken by humanitarian crisis actors. Finally, we tested the relationships between Sensemaking and information load as well as Sensemaking and information sharing.

The second foundation is the advancement towards Sensemaking support by IS. We provided suggestions for each of the seven Sensemaking properties. We demonstrated that seven DERMIS design premises should form a backbone for the design of SSS. Moreover, we provided guidelines on how to support humanitarian crisis response actors in their Sensemaking communication activities to reach an individual understanding. Finally, we tested the effect of two GSS settings on Sensemaking.

The third foundation is the introduction of how to measure Sensemaking attainment in groups. As we have exemplified in an experimental study, the measurement of group Sensemaking attainment enables researchers and practitioners to use Sensemaking as independent or dependent variable in studies, e.g., to estimate the impact of IS on Sensemaking as well as Sensemaking on performance. Therefore, it provides the means for optimal design, robust development, and solid testing of SSS.

6.3 Future Research

The limitations of this research as well as its implications for research and practice have been provided in the previous chapters. This dissertation, just like the research and ideas on which it is based, should not be perceived as an end on itself, but rather as a means and as a starting point of multiple research paths. Below we provide suggestions.

Future research could use our foundations to further explore how information systems, organizational structures, and policies affect Sensemaking. Research should determine how the best Sensemaking conditions are created, depending on the context, the Sensemaking purpose, and the actors involved. This research is relevant in (humanitarian) crisis response as well as in other domains, such as (IT-)auditing, marketing, criminal intelligence analysis, and public governance.

In this study we took into account two out of seven specific properties of Sensemaking: social and ongoing. Future studies should extend the concept of Sensemaking to measure and identify the effect of the other Sensemaking properties on information processes and performance.

The role of information overload is important in humanitarian crisis response and merely touched upon in this dissertation. Many of our respondents indicated that they daily receive an abundance of information when responding to a crisis, far more than they can possibly process. Future research could more extensively examine the role of information overload on Sensemaking, and investigate how SSS can provide means for actors to deal with this information processing burden.

In our research we mainly focused on response to sudden-onset crises. In future (humanitarian) crisis response studies, research could be directed at examining the role of Sensemaking and information overload in slow-onset crises and more complex emergencies.

Future research could link the role of Sensemaking to other well-established and relevant literature. For instance, researchers could explore the influence of established teams versus ad-hoc teams and the implication of experts in a team versus novices on information sharing, Sensemaking and performance. The needs assessment procedures at the Triplex exercise were designed to be used by ad-hoc teams of novices, which seems to be counterproductive according to well-established Sensemaking literature. This highlights the importance of a shared frame of reference, which established groups have already developed.

In the light of the importance of Sensemaking in group decision making, previous (hidden profile) research designs could be adapted to re-examine this mediating effect. For example, the influence of group size on information sharing has shown to be insignificant (e.g., Mennecke, 1997). However, group size is expected to affect social Sensemaking.

Future research could be directed at incorporating our findings into an emergency management wide “continuous auditing” process (Turoff et al., 2004). By having made decision making and particularly Sensemaking processes more explicit, it is in principle possible to track them and evaluate their emergency preparedness and response status continuously.

Appendices

Appendix A: Overview of Interviews

Case study	Date	Interview Location	Organization or role	Number of interviewees
Barents Rescue Exercise	10/19/2007	Saariselkä	OSOCC	1
	10/20/2007	Ivalo	OSC	1
	10/20/2007	Ivalo	Medical team	1
	10/21/2007	Saariselkä	LEMA	1
Forest fires in Portugal	12/12/2008	Lisbon	Portuguese Forest Services	2
	12/13/2008	Lisbon	ANPC	2
	02/29/2008	Brussels	EC, Environment DG	1
	02/29/2008	Brussels	EU Council, Civil Protection Unit	1
EUPM in BiH	04/08/2008	Sarajevo	EUPM	1
	04/08/2008	Sarajevo	EUPM, EU Coordination Office	1
	04/08/2008	Sarajevo	EUPM, Security Dept.	1
	04/08/2008	Sarajevo	EUPM, Public Information Dept.	1
	04/08/2008	Sarajevo	EUPM, Public Information Dept.	1
	04/09/2008	Sarajevo	EC, Department Police Projects	1
	04/09/2008	Sarajevo	EUFOR	1
	04/09/2008	Sarajevo	EUSR	1
	04/10/2008	Sarajevo	Canton Sarajevo Police Dept.	3
	04/10/2008	Sarajevo	OSCE	1
	04/10/2008	Sarajevo	OSCE, Security Cooperation Dept.	2
	04/11/2008	Sarajevo	Populari	1
The DRC's ongoing crisis	08/08/2007	Kinshasa	ASF	1
	08/08/2007	Kinshasa	SIDA	1
	08/08/2007	Kinshasa	MSF Belgium	1
	08/09/2007	Kinshasa	Save the Children	1
	08/09/2007	Kinshasa	Oxfam GB	1
	08/09/2007	Kinshasa	ICRC	2
	08/10/2007	Kinshasa	UNFPA	1
	08/10/2007	Kinshasa	UNDP	1
	08/10/2007	Kinshasa	OCHA	1
	08/10/2007	Kinshasa	WFP	1
	08/10/2007	Kinshasa	UNICEF	3
	08/13/2007	Kinshasa	Belgian Embassy	1
	08/13/2007	Kinshasa	MONUC	1
	08/13/2007	Kinshasa	ECHO	1
	08/13/2007	Kinshasa	CRS	2
	08/14/2007	Kinshasa	WHO	1
	08/14/2007	Kinshasa	DFID	2

Appendix B: Sensemaking Survey

Survey items related to the statements on social Sensemaking, ongoing Sensemaking, and Sensemaking outcome. After each item we mention the “itemID” and refer to the matching statement from the previously discussed theory which the respective item is aimed at measuring. Please note that the headers of the sections (Social Sensemaking, Ongoing Sensemaking, and Sensemaking Outcome), the itemIDs and the references to the statements were not visible to the respondents. They were only presented the survey items on their screen in this order, six at a time.

Social Sensemaking

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

It was easy to fall back on my team members for information, questions, feedback, and reflection
[itemID = social1; statement 1 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

The use of the communication medium ([radio/chat]) encouraged me to discuss with my team members
[itemID = social2; statement 2 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

After the group discussion had started, I sometimes felt isolated when trying to solve the case
[itemID = social3; statement 3 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

There was a lot of discussion in the team
[itemID = social4; statement 4 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

I would have wanted to discuss more than we actually did
[itemID = social5; statement 5 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

All my team members actively participated in the experiment
[itemID = social6; statement 6 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

We were critically comparing different pieces of information to each other
[itemID = social7; statement 7 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

My team members were not always carefully considering my information inputs
[itemID = social8; statement 8 in Subsection 4.2.1]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

We focused on the contrary views within the team
[itemID = social9; statement 9 in Subsection 4.2.1]

Ongoing Sensemaking

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

The decision making process in our group was smooth and continuous
[itemID = ongoing1; statement 10 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

I did not always understand what my team members were thinking or doing
[itemID = ongoing2; statement 11 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

I did not always have a chance to contribute to the discussion when I wanted to
[itemID = ongoing3; statement 12 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

Our team paid extra attention to situations in which our expectations or beliefs were disconfirmed
[itemID = ongoing4; statement 13 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

It was not always easy to focus the group's attention to the issues I wanted to discuss
[itemID = ongoing5; statement 14 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)
☐ ☐ ☐ ☐ ☐

Our team managed to translate the starting situation, in which there were many unclarities, into a situation in which it was more understandable what was going on
[itemID = ongoing6; statement 15 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)
☐ ☐ ☐ ☐ ☐

We managed to react swiftly to the unclarities to create a more understandable picture of the situation
[itemID = ongoing7; statement 16 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)
☐ ☐ ☐ ☐ ☐

We continuously updated our actions and interpretations according to new information
[itemID = ongoing8; statement 17 in Subsection 4.2.2]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)
☐ ☐ ☐ ☐ ☐

During the group discussion, when new information was brought up, I was trying to analyze and understand the situation myself before sharing my thoughts with my team members
[itemID = ongoing9; statement 18 in Subsection 4.2.2]

Sensemaking Outcome

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

In our team, we had a good idea of which direction to follow
[itemID = outcome1; statement 19 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

In our team, we had a good understanding of the uncertainties we faced
[itemID = outcome2; statement 20 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

In our team, we were able to develop a coherent story of what was going on
[itemID = outcome3; statement 21 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

In our team, it was hard to build a common idea of what was happening
[itemID = outcome4; statement 22 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

○ ○ ○ ○ ○

In our team, we updated and developed our initial sense of the situation
[itemID = outcome5; statement 23 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

In our team, we experienced at some point a total lack of meaning of what was happening
[itemID = outcome6; statement 26 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

In our team, we stuck to one view of what was happening
[itemID = outcome7; statement 24 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

In our team, our grasp of what was happening sometimes began to loosen
[itemID = outcome8; statement 27 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

In our team, we were resourceful in the face of setbacks
[itemID = outcome9; statement 25 in Subsection 4.2.3]

Strongly Agree (1) Agree (2) Neutral (3) Disagree (4) Strongly Disagree (5)

☐ ☐ ☐ ☐ ☐

In our team, we had the feeling of order, clarity, and rationality
[itemID = outcome10; statement 28 in Subsection 4.2.3]

Appendix C: Intraclass Correlation Coefficient

Interrater reliability is a measure for the relative consistency of responses among raters (Bliese 2000, p.354), and non-independence is the degree to which responses from individuals in the same group are influenced by and depend on the group membership (Bliese, 2000). Both interrater reliability and non-independence are important criteria for aggregation, as they indicate whether individuals within a group can meaningfully indicate their group's behavior.

Both interrater reliability and non-independence are most commonly estimated by the Intraclass Correlation Coefficient (ICC) 1 (Shrout and Fleiss 1979; Bartko 1976; McGraw and Wong 1996). The ICC(1) is based on the one-way random effects Analysis of Variance (ANOVA) in which the groups are treated as the random effect. ICC(1) is estimated when one is interested in understanding the interrater reliability among multiple groups rated by a different set of individuals on an interval measurement scale, such as Likert-type scales (LeBreton and Senter, 2008). ICC(1) is defined as

$$ICC(1) = \frac{MS_B - MS_W}{MS_B + (k - 1) MS_W}, \quad (A.1)$$

where MS_B is the Mean Square Between groups, MS_W is the Mean Square Within groups, and k is the group size. The value of ICC(1) indicates the effect size, i.e. the percentage of variance explained. ICC(1) values can be interpreted either as the level of consensus and consistency one would expect if an individual is randomly selected and his or her scores were compared to the mean score obtained from the sample of individuals (LeBreton and Senter, 2008), or and can be interpreted as the extent to which individual responses were affected by their group membership (Bliese, 2000).

The accompanying F-test tests the hypothesis:

$$H_0: MS_B - MS_W = 0$$

(The between-group variance is equal to the within-group variance)

against the alternative hypothesis:

$$H_1: MS_B - MS_W > 0$$

(The between-group variance is greater than the within-group variance)

Appendix D: Item Response Theory

As the trait which IRT is aimed at measuring is latent, i.e. not known, IRT uses the unweighted total score on the items in a test to estimate Θ . For polytomous items, in our case based on a 5-points Likert scale, the answer categories of the items need to have a meaningful order representing increasingly higher levels of the latent trait. The test score for k polytomous items is defined as (Sijtsma and Molenaar, 2002, p.118):

$$X_+ = \sum_{i=1}^k X_i, \quad (\text{A.2})$$

with $X_i = 0, 1, \dots, m$ for all $i = 1, \dots, k$ items. This means that an item has $m + 1$ ordered answer categories. The higher the latent trait value Θ of a group, estimated by X_+ , the higher the probability of correctly answering an item that measures Θ .

Because polytomous items have more than two response options, these scoring probability on these items are indicated with multiple response functions, called ISRFs. The ISRF is defined as (Sijtsma and Molenaar, 2002, p.119):

$$P_{ih}(\Theta) = P(X_i \geq h | \Theta), \quad (\text{A.3})$$

with index h indicating polytomous item scores and $h = 0, \dots, m$; and $i = 1, \dots, k$. This equation gives the probability of scoring at least h on item i . Because $h = 0$ leads to a probability of 1 for each Θ , which is not informative about item functioning, each item with $m + 1$ answer categories has m meaningful ISRFs.

Quality indices for MHM scales

There are three types of quality indices for MHM scales: The scalability coefficient H_i for each item, the scalability coefficient H_{ij} for all item pairs, and the scalability coefficient H for all k items simultaneously. The scalability coefficient H_i of item i can be defined as (Sijtsma and Molenaar, 2002, p.57):

$$H_i = \frac{\text{Cov}(X_i, R_{(i)})}{\text{Cov}_{\max}(X_i, R_{(i)})}, \quad (\text{A.4})$$

with rest score $R_{(i)}$ representing the sum score across the $k - 1$ other items. This item scalability coefficient can be interpreted as an index for the steepness of the slope of the ISRFs, indicating the strength of the association of item i with the other $k - 1$ items in the scale and the degree of discrimination with which item i can separate low and high Θ values. The MHM implies $0 < H_i \leq 1$.

Similarly, the scalability coefficient H_{ij} for all item pairs represents the extent to which two items fit together, and is defined as (Sijtsma and Molenaar, 2002, p.55):

$$H_{ij} = \frac{\text{Cov}(X_i, X_j)}{\text{Cov}_{\max}(X_i, X_j)}. \quad (\text{A.5})$$

The MHM implies $0 \leq H_{ij} \leq 1$.

Finally, the scalability coefficient H for all k items simultaneously is defined as (Sijtsma and Molenaar, 2002, p.57):

$$H = \frac{\sum_i Cov(X_i, R_{(i)})}{\sum_i Cov_{max}(X_i, R_{(i)})}. \quad (\text{A.6})$$

The scalability coefficient H is the weighted mean of all H_i values, and can be interpreted as the discrimination index for accuracy of person ordering by means of X_+ on the latent trait Θ . The MHM implies $0 < H \leq 1$.

Appendix E: Data Transformation to Group Sum Categories

Transformation of the five items for analysis: From 13 categories according to the group sum, to 10 categories in which the lowest group sum teams are aggregated.

Table A.1: Original categories according to the group responses

Group sum	Frequency social5	Frequency ongoing1	Frequency outcome5	Frequency outcome8	Frequency outcome10
0	1				
1					
2	3			1	
3	4			2	1
4	4	1		4	
5	9	3		4	
6	4	2	1	4	3
7	10	2	4	9	1
8	10	5	2	7	5
9	2	8	16	13	10
10	1	17	15	4	19
11		9	6		5
12		1	4		4

Table A.2: New response categories with the lowest group sum teams aggregated into the lowest response category

Response category	Group sum	Frequency social5	Frequency ongoing1	Frequency outcome5	Frequency outcome8	Frequency outcome10
0	0-3	8			3	1
1	4	4	1		4	
2	5	9	3		4	
3	6	4	2	1	4	3
4	7	10	2	4	9	1
5	8	10	5	2	7	5
6	9	2	8	16	13	10
7	10	1	17	15	4	19
8	11		9	6		5
9	12		1	4		4

Appendix F: MSP5 Output, MHM Scale Analysis

MSPWIN version 5.0, developed by ProGAMMA

[|010 Input specifications]

```
TITLE=''/
VARIABLES=social5,ongoing1,outcome5,outcome8,outcome10/
FORMAT=FREEFIELD/
LABELS=
social5 'I would have wanted to discuss'
ongoing1 'The decision making process in'
outcome5 'In our team, we updated and de'
outcome8 'In our team, our grasp of what'
outcome10 'In our team, we had the feelin'/
CONDITION=ALL/
SKIP=NO/
ITEMS=social5,ongoing1,outcome5,outcome8,outcome10 (0,9) /
CASEID=groupID/
STEPORDER=COMMON/
H=WEIGHTED/
ANALYSIS= social5 ongoing1 outcome5 outcome8 outcome10/
TYPE=TEST/
LOWERBOUND=0.3000/
ALPHA=0.0500/
NSCALES=2/
CHECK=SINGLE(MINVI=0.0300,SIGLEVEL=0.0500,MINSIZE=10,social5,ongoing1,outcome5,outcome8,outcome10)/
RELIABILITY=YES/
PRINT=FULL ORDERED PPLUS PMIN PEST GUTTMAN *
```

[|030 Univariate frequencies and item means for entire group (n=48)]

Item	Mean	Values									
		0	1	2	3	4	5	6	7	8	9
social5	2.98	8	4	9	4	10	10	2	1	0	0
ongoing1	6.12	0	1	3	2	2	5	8	17	9	1
outcome5	6.54	0	0	0	1	4	2	16	15	6	4
outcome8	4.19	3	4	4	4	9	7	13	4	0	0
outcome10	6.40	1	0	0	3	1	5	10	19	5	4

[Analysis 1 |040 Matrix of H values per item pair]

Items				
	social5	outcome8	ongoing1	outcome10
social5				
outcome8	0.45			
ongoing1	0.30	0.54		
outcome10	0.34	0.47	0.83	
outcome5	0.12	0.26	0.62	0.60

```
Number of items in matrix      :    5
Total number of H-values      :   10
Total number of negative H-values:    0
```


[Analysis 1 |042 Matrix Z(g,h)]

Items

	social5	outcome8	ongoing1	outcome10
social5				
outcome8	2.95			
ongoing1	1.87	3.49		
outcome10	2.05	2.95	5.40	
outcome5	0.74	1.67	3.97	3.88

[Analysis 1 |044 Overview final scale]
for scale tested, Number of Items: 5

n = 48 Scale coefficient H = 0.46 Scale Z = 9.02

Item coefficients		Mean	ItemH	Z
Item	Label			
social5	I would have wanted to discuss	2.98	0.32	3.97
outcome8	In our team, our grasp of what	4.19	0.44	5.64
ongoing1	The decision making process in	6.12	0.56	7.12
outcome10	In our team, we had the feelin	6.40	0.56	6.96
outcome5	In our team, we updated and de	6.54	0.39	4.98

[Analysis 1 |100 Summary per item for check of monotonicity]

Minimum violation = 0.03 Significance level= 0.05 Minimum group size= 10

	ItemH	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	#zsig	crit
social5	0.32	30	4	0.13	0.12	0.39	0.0131	0.31	0	47*
ongoing1	0.56	17	2	0.12	0.11	0.18	0.0109	-0.19	0	25
outcome5	0.39	17	3	0.18	0.08	0.20	0.0119	-0.23	0	37
outcome8	0.44	24	2	0.08	0.20	0.30	0.0125	0.66	0	43
outcome10	0.56	19	2	0.11	0.08	0.17	0.0088	0.00	0	20

[Analysis 1 |110 Details per itemstep for check of monotonicity]
 Minimum violation = 0.03 Significance level= 0.05 Minimum group size= 10

social5 I would have wanted to discuss

Restscore			N	Frequencies per item value										Mean	Proportions of positive responses per itemstep								
Group	Low	High		0	1	2	3	4	5	6	7	8	9		>= 1	>= 2	>= 3	>= 4	>= 5	>= 6	>= 7	>= 8	>= 9
1	5	- 19	10	3	1	3	0	1	2	0	0	0	0	2.10	0.70	0.60	0.30	0.30	0.20	0.00	0.00	0.00	0.00
2	20	- 22	10	3	1	1	2	2	1	0	0	0	0	2.20	0.70	0.60	0.50	0.30	0.10	0.00	0.00	0.00	0.00
3	23	- 26	11	0	1	3	1	3	2	0	1	0	0	3.55	1.00	0.91	0.64	0.55	0.27	0.09	0.09	0.00	0.00
4	27	- 33	17	2	1	2	1	4	5	2	0	0	0	3.59	0.88	0.82	0.71	0.65	0.41	0.12	0.00	0.00	0.00

	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	group	#zsig
Itemstep >= 1	4	1	0.25	0.12	0.12	0.0294	0.27	3 4	0
Itemstep >= 2	6	1	0.17	0.09	0.09	0.0143	0.00	3 4	0
Itemstep >= 3	6	0							
Itemstep >= 4	6	0							
Itemstep >= 5	6	1	0.17	0.10	0.10	0.0167	0.00	0 0	0
Itemstep >= 6	1	0							
Itemstep >= 7	1	1	1.00	0.09	0.09	0.0909	0.31	3 4	0
Itemstep >= 8	0								
Itemstep >= 9	0								
Itemtotal	30	4	0.13	0.12	0.39	0.0131	0.31	0	47

ongoing1 The decision making process in

Restscore				N	Frequencies per item value									Mean	Proportions of positive responses per itemstep								
Group	Low	High	0		1	2	3	4	5	6	7	8	9		>= 1	>= 2	>= 3	>= 4	>= 5	>= 6	>= 7	>= 8	>= 9
1	4	- 16	13	0	1	3	1	1	2	1	3	1	0	4.54	1.00	0.92	0.69	0.62	0.54	0.38	0.31	0.08	0.00
2	17	- 20	10	0	0	0	1	0	3	4	2	0	0	5.60	1.00	1.00	1.00	0.90	0.90	0.60	0.20	0.00	0.00
3	21	- 23	13	0	0	0	0	1	0	1	8	3	0	6.92	1.00	1.00	1.00	1.00	0.92	0.92	0.85	0.23	0.00
4	24	- 29	12	0	0	0	0	0	0	2	4	5	1	7.42	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.50	0.08

	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	group	#zsig
Itemstep >= 1	0								
Itemstep >= 2	0								
Itemstep >= 3	0								
Itemstep >= 4	1	0							
Itemstep >= 5	3	0							
Itemstep >= 6	3	0							
Itemstep >= 7	6	1	0.17	0.11	0.11	0.0179	0.08	1 2	0
Itemstep >= 8	4	1	0.25	0.08	0.08	0.0192	-0.19	1 2	0
Itemstep >= 9	0								
Itemtotal	17	2	0.12	0.11	0.18	0.0109	-0.19	0	25

outcome5 In our team, we updated and de

Restscore			N	Frequencies per item value										Mean	Proportions of positive responses per itemstep									
Group	Low	High		0	1	2	3	4	5	6	7	8	9		>= 1	>= 2	>= 3	>= 4	>= 5	>= 6	>= 7	>= 8	>= 9	
1	2	- 14	11	0	0	0	1	2	2	4	2	0	0	5.36	1.00	1.00	1.00	0.91	0.73	0.55	0.18	0.00	0.00	
2	15	- 20	13	0	0	0	0	1	0	4	5	3	0	6.69	1.00	1.00	1.00	1.00	0.92	0.92	0.62	0.23	0.00	
3	21	- 24	11	0	0	0	0	0	0	4	5	2	0	6.82	1.00	1.00	1.00	1.00	1.00	1.00	0.64	0.18	0.00	
4	25	- 29	13	0	0	0	0	1	0	4	3	1	4	7.15	1.00	1.00	1.00	1.00	0.92	0.92	0.62	0.38	0.31	

	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	group	#zsig
Itemstep >= 1	0								
Itemstep >= 2	0								
Itemstep >= 3	0								
Itemstep >= 4	0								
Itemstep >= 5	4	1	0.25	0.08	0.08	0.0192	-0.12	3 4	0
Itemstep >= 6	4	1	0.25	0.08	0.08	0.0192	-0.12	3 4	0
Itemstep >= 7	6	0							
Itemstep >= 8	3	1	0.33	0.05	0.05	0.0163	-0.23	2 3	0
Itemstep >= 9	0								
Itemtotal	17	3	0.18	0.08	0.20	0.0119	-0.23	0	37

outcome8 In our team, our grasp of what

Restscore				N	Frequencies per item value									Mean	Proportions of positive responses per itemstep								
Group	Low	High	0		1	2	3	4	5	6	7	8	9		>= 1	>= 2	>= 3	>= 4	>= 5	>= 6	>= 7	>= 8	>= 9
1	4	- 19	10		1	2	4	1	2	0	0	0	0		0	2.10	0.90	0.70	0.30	0.20	0.00	0.00	0.00
2	20	- 21	11	1	2	0	1	3	2	1	1	0	0	3.64	0.91	0.73	0.73	0.64	0.36	0.18	0.09	0.00	0.00
3	22	- 24	12	1	0	0	1	1	1	6	2	0	0	5.17	0.92	0.92	0.92	0.83	0.75	0.67	0.17	0.00	0.00
4	25	- 31	15	0	0	0	1	3	4	6	1	0	0	5.20	1.00	1.00	1.00	0.93	0.73	0.47	0.07	0.00	0.00

	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	group	#zsig
Itemstep >= 1	3	0							
Itemstep >= 2	3	0							
Itemstep >= 3	3	0							
Itemstep >= 4	6	0							
Itemstep >= 5	3	0							
Itemstep >= 6	3	1	0.33	0.20	0.20	0.0667	0.66	3 4	0
Itemstep >= 7	3	1	0.33	0.10	0.10	0.0333	0.24	3 4	0
Itemstep >= 8	0								
Itemstep >= 9	0								
Itemtotal	24	2	0.08	0.20	0.30	0.0125	0.66	0	43

outcome10		In our team, we had the feelin																											
Restscore		Frequencies per																			Proportions of positive								
Group		Low	High	N	item value									Mean	responses per itemstep														
					0	1	2	3	4	5	6	7	8	9		>= 1	>= 2	>= 3	>= 4	>= 5	>= 6	>= 7	>= 8	>= 9					
1	5	-	15	12	1	0	0	2	0	3	4	2	0	0	4.92	0.92	0.92	0.92	0.75	0.75	0.50	0.17	0.00	0.00					
2	17	-	20	12	0	0	0	0	1	2	4	4	0	1	6.25	1.00	1.00	1.00	1.00	0.92	0.75	0.42	0.08	0.08					
3	21	-	23	12	0	0	0	1	0	0	1	8	2	0	6.75	1.00	1.00	1.00	0.92	0.92	0.92	0.83	0.17	0.00					
4	24	-	28	12	0	0	0	0	0	0	1	5	3	3	7.67	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.50	0.25					

	#ac	#vi	#vi/#ac	maxvi	sum	sum/#ac	zmax	group	#zsig
Itemstep >= 1	0								
Itemstep >= 2	0								
Itemstep >= 3	0								
Itemstep >= 4	2	1	0.50	0.08	0.08	0.0417	0.00	0 0	0
Itemstep >= 5	3	0							
Itemstep >= 6	3	0							
Itemstep >= 7	6	0							
Itemstep >= 8	3	0							
Itemstep >= 9	2	1	0.50	0.08	0.08	0.0417	0.00	0 0	0
Itemtotal	19	2	0.11	0.08	0.17	0.0088	0.00	0	20

Illustrative interpretation of the results

The second step in the MHM scale analysis is to calculate the ISRFs based on the rest score groups. MSP5 also presents graphs of the ISRFs for all items if there are violations of monotonicity, i.e. if one or more of the ISRFs for each item show a decrease in the proportions of positive responses for higher rest score groups. All five items have such local decreases in the ISRFs. Numerically this can be seen in the “details per itemstep for check of monotonicity” on the pages in landscape page layout. For each item it can be first seen that it shows increasing mean values for higher rest score groups. Second, however, each item shows that there are instances in which a higher rest score group had a lower score for that specific item. For example, if we observe the results for social5, we see that rest score group 3 consists of 11 teams who scored between 23 and 26 on the other four items. One of these teams scored 7 on social5, leading to a proportion of 0.09 of positive responses for item $\text{step} \geq 7$. None of the 17 teams from rest score group 4, scoring between 27 and 33 on the other four items, however scored 7 or higher for social5. This is in contrast to the monotonicity assumption, as we would expect that teams scoring higher on the other four items, which measure the same latent trait, should have a higher proportion correct score for the fifth item. This is a so-called “Guttman error” (Guttman, 1950). Next it is therefore shown that there is one violation of monotonicity for itemstep ≥ 7 ($\#vi = 1$), which is a maximum violation of 0.09 (\maxvi), but when tested for significance (with $\alpha = 0.05$) it shows that this violation is not significant (there are no significant violations, as can be seen in the last column “ $\#zsig$ ”). It is probably not significant because the mean score on social5 of rest score group 4, which is 3.59, is larger than the mean value of rest score group 4 on social5 (3.55). When observing the violations for all five items, we can see that none of them exhibit a significant violation of monotonicity. The summary per item for check of monotonicity can be consulted in last section before the landscape page layout starts. There is *manifest monotonicity* in our data as there are no significant decreases in the ISRFs, which supports the assumption of latent monotonicity.

Appendix G: Hidden Profile Item Distributions

Table A.3: Hidden profile item distributions for the two information load conditions

		Low information load condition				High information load condition			
Item	Category	District	Alpha	Bravo	Charlie	District	Alpha	Bravo	Charlie
A1+	Health	Norktown	1	1	1	Norktown	1	1	1
A1−	Health	Norktown	0	0	1	Norktown	0	0	1
A2+	Water, sanitation and hygiene	Norktown	1	1	1	Norktown	1	1	1
A2−	Water, sanitation and hygiene	Norktown	0	1	0	Norktown	0	0	1
A3+	Food and nutrition	Norktown	1	1	1	Norktown	1	1	1
A3−	Food and nutrition	Norktown	1	0	0	Norktown	1	0	0
A4+	Shelter and non-food items	Norktown	1	1	1	Norktown	1	1	1
A4−	Shelter and non-food items	Norktown	1	0	0	Norktown	1	0	0
A5+	Logistics, access and security	Norktown	0	1	0	Norktown	1	1	1
A5−	Logistics, access and security	Norktown	1	0	0	Norktown	0	1	0
A6+	Protection					Norktown	1	1	1
A6−	Protection					Norktown	0	1	0
A7+	Water, sanitation and hygiene					Norktown	1	0	0
A7−	Water, sanitation and hygiene					Norktown	0	0	1
A8+	Food and nutrition					Norktown	0	1	0
A8−	Food and nutrition					Norktown	1	1	1
A9+	Shelter and non-food items					Norktown	0	1	0
A9−	Shelter and non-food items					Norktown	0	0	1
A10+	Logistics, access and security	Norktown	0	0	1	Norktown	1	0	0
A10−	Logistics, access and security	Norktown	1	0	0	Norktown	1	1	1
A11−	Health	Norktown	1	0	0	Norktown	1	0	0
A12−	Water, sanitation and hygiene	Norktown	0	0	1	Norktown	0	1	0
A13−	Shelter and non-food items	Norktown	0	1	0	Norktown	0	0	1
A14−	Logistics, access and security					Norktown	0	0	1
A15−	Food and nutrition					Norktown	0	0	1

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Table A.3 – continued from previous page

Item	Category	Low load condition				High load condition			
		District	Alpha	Bravo	Charlie	District	Alpha	Bravo	Charlie
B1+	Health	Petersted	0	1	0	Grotti	1	1	1
B1–	Health	Petersted	1	1	1	Grotti	1	1	1
B2+	Water, sanitation and hygiene	Petersted	1	1	1	Grotti	1	0	0
B2–	Water, sanitation and hygiene	Petersted	0	0	1	Grotti	1	1	1
B3+	Food and nutrition	Petersted	0	0	1	Grotti	1	1	1
B3–	Food and nutrition	Petersted	1	1	1	Grotti	0	1	0
B4+	Shelter and non-food items	Petersted	0	0	1	Grotti	0	1	0
B4–	Shelter and non-food items	Petersted	0	1	0	Grotti	1	1	1
B5+	Logistics, access and security	Petersted	1	1	1	Grotti	1	1	1
B5–	Logistics, access and security	Petersted	0	1	0	Grotti	1	0	0
B6+	Protection					Grotti	1	1	1
B6–	Protection					Grotti	1	1	1
B7+	Water, sanitation and hygiene					Grotti	1	1	1
B7–	Water, sanitation and hygiene					Grotti	1	1	1
B8+	Food and nutrition					Grotti	1	0	0
B8–	Food and nutrition					Grotti	0	0	1
B9+	Shelter and non-food items					Grotti	1	1	1
B9–	Shelter and non-food items					Grotti	1	0	0
B10+	Logistics, access and security	Petersted	0	1	0	Grotti	0	1	0
B10–	Logistics, access and security	Petersted	0	0	1	Grotti	1	1	1
B11–	Health	Petersted	0	1	0	Grotti	0	1	0
B12–	Water, sanitation and hygiene	Petersted	1	0	0	Grotti	1	0	0
B13–	Shelter and non-food items	Petersted	0	0	1	Grotti	0	1	0
B14–	Logistics, access and security					Grotti	0	1	0
B15–	Food and nutrition					Grotti	1	0	0
C1+	Health	Grotti	1	0	0	Petersted	1	1	1
C1–	Health	Grotti	1	1	1	Petersted	1	0	0
C2+	Water, sanitation and hygiene	Grotti	1	0	0	Petersted	0	1	0

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Table A.3 – continued from previous page

Item	Category	Low load condition				High load condition			
		District	Alpha	Bravo	Charlie	District	Alpha	Bravo	Charlie
C2–	Water, sanitation and hygiene	Grotti	1	1	1	Petersted	1	1	1
C3+	Food and nutrition	Grotti	1	1	1	Petersted	0	0	1
C3–	Food and nutrition	Grotti	0	1	0	Petersted	1	1	1
C4+	Shelter and non-food items	Grotti	1	0	0	Petersted	0	0	1
C4–	Shelter and non-food items	Grotti	1	1	1	Petersted	1	1	1
C5+	Logistics, access and security	Grotti	1	1	1	Petersted	0	0	1
C5–	Logistics, access and security	Grotti	0	0	1	Petersted	1	1	1
C6+	Protection					Petersted	0	0	1
C6–	Protection					Petersted	1	1	1
C7+	Water, sanitation and hygiene					Petersted	1	1	1
C7–	Water, sanitation and hygiene					Petersted	0	1	0
C8+	Food and nutrition					Petersted	1	1	1
C8–	Food and nutrition					Petersted	1	1	1
C9+	Shelter and non-food items					Petersted	1	1	1
C9–	Shelter and non-food items					Petersted	1	1	1
C10+	Logistics, access and security	Grotti	1	1	1	Petersted	1	1	1
C10–	Logistics, access and security	Grotti	1	1	1	Petersted	1	1	1
C11+	Health	Grotti	1	0	0	Petersted	0	0	1
C12+	Water, sanitation and hygiene	Grotti	0	0	1	Petersted	0	0	1
C13+	Shelter and non-food items	Grotti	0	1	0	Petersted	1	0	0
C14+	Logistics, access and security					Petersted	1	0	0
C15+	Food and nutrition					Petersted	0	1	0

a “+” indicates a positive information item;

a “–” indicates a negative information item;

a “1” indicates the possession of the information item by the respective team member;

a “0” indicates that the respective team member did not possess the respective information item.

(i.e. three times “1” indicates a common information item, while one “1” and two times “0” indicates a unique information item)

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